KUMBHA MELA

History and Religion; Astronomy and Cosmobiology

by

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Dedicated to

SWAMI YOGANAND PARAMHANSHJI MAHARAJ

CONTENTS

PREFACE

An analysis of the genesis, symbols and merits of the *Kumbha* indicates that the legendary *Parva (Amrit Kumbha)* and the *Mela* named after it presents inseparably two different aspects of Indian life. The attributes of the former refer to philosophical *Kumbha* that could only provide the spiritual benefits. The merits of the latter,on the other hand, are related to spatio-temporal bioeffects of the planetary radiations, particularly of sunspots, lunar phases and other cosmic bodies in conjunction with the bath benefits from the concerned rivers. To provide greater antiquity and validity to the latter, the mythological symbolisms of the former were attached with it, however, in course of time. In the confounded origin of the *Kumbha*, thus the elements of macrocosm, such as, planets, gods, demons, milk ocean, *Kumbha* sites, etc., represent their counterparts i.e. plexus and system in the microcosm (body) i.e. that involve in arousal of the serpentine power. Thus the legendary origin of the *Amrit Kumbha* refers to the arousal of serpentine power by celebrating the *Kumbha Parva* of the microcosm with the help of various elements. The *Mela* of the macrocosm, on the other hand, represents the scientific religion of *Hindus*.

It deserves mention that these twin aspects of the *Kumbha* have not been analytically studied so far, and all the previous writings are generally ambiguous and misleading due to their confounded treatments. To trace the origin and ascertain the antiquity, and to

understand the significance of the twin aspects of the *Kumbha*, it is, therefore, essential to analyse the things related with the *Kumbhas* The first part of the present study is an humble attempt to deal with the origin and antiquity of both facets of the *Kumbha*, and to explain the spiritual symbolism as reflected by the elements of the *Mela*.

The second part of the present study aims at introducing the audience about the celestial phenomena that variously affect the life and environment of our planet. It demonstrates that various planetary configurations play crucial role to govern the phenomena at Sun and thereby to alter solar radiation, which is held to influence our planet. The world famous *Kumbha Mela* has been found associated with solar cycle, and its great bath, with lunar phases There are accumulating evidence that solar radiation from Sun at sunspot maxima and on new and full Moon day not only influence the environment at Earth, but the associated geomagnetic fluctuations and electrical environment coupled with enhanced level of ionizing and non-ionizing radiations modify the physiological and bio-chemical behaviour of the living systems. This study shows that *Kumbha Mela* held at different time and space is based on the consideration of beneficial cosmobiological effects.

The book contains lively photographs of the *Mela* (fair) scenario that may revive the memory of those who ever visited it, and could present a panoramic view of the *Mela* before the non-visitors.

The author is grateful to a number of scholars, both oriental as well as modern, for consulting their works in preparation of this work.

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Varanasi **Subas Rai**

PART - I

KUMBHA MELA : HISTORY AND RELIGION

CHAPTER 1

INTRODUCTION

Kumbha Mela is the greatest of the Indian pilgrimages and the largest of the world's religions This river-side religious fair is held every three years, rotating between Hardwar on the *Ganges*, Ujjain on the *Sipra*, Nasik on the *Godavari* and Prayag, at the confluence (*Sangam*) of the *Ganges*, the *Yamuna* and the mythical *Saraswati*. On this occasion millions of pilgrims from every nook and corner of the land, speaking different languages, wearing different and distinct sectarian marks, donning different types of dresses and observing various manners and customs, meet together for a holy dip in the sacred waters of the above rivers. For this no invitation is given, no propaganda is carried out and over all no authority exists for carrying out all these businesses

This *Mela* presents the kaleidoscopic view of a mini-*Bharat*, where trans-sectarian *Hindus* realize that they are one on the issue of virtues of the bath and experience and understanding of the invisible ultimate reality of wholeness and oneness, in the same way as does a pilgrimage to Mecca to *Muslims* and Yerushalam to *Christians* of different quarters of the world. As the greatest religious fair and the highest state of water

symbolism, it displays a vibrating paradigm of *Hinduism* both at its best and its worst and represents the microcosm of Indian civilization. This *Mela* in its gorgeous form, reminds us of our marvelous religious and spiritual heritage, and helps to maintain national integration by arousing psycho-traditional urges of the people.

There are few *Melas* in India as traditionally *Hindu* and symbolic of the whole *Hindu* culture, and in the world, as challenging and bewildering to visitors from other parts of the world as the *Kumbha Mela* is. In the *Mela* one is confronted with the notion of the trajectories of cosmic forces, symbolized by moving planets and constellations and flowing rivers and human life Millions who go for pilgrimage to the *Kumbha Mela* are drawn by the prospects, either or both, of coming into contact with rare *Sadhus*, who not only inspire spiritual seekers, but also play a highly significant social role by acting as our monitors and legislators, and bathing in the time hallowed rivers charged with everlasting spiritual vibrations by the meditations and prayers of thousands of saints since the dawn of time. If it is true that every thought creates a trail of everlasting vibrations, it is also true that no sound or *Nada* is annihilated but only stored in the earth-consciousness, and that one can attune oneself to distant or even bygone melodies. Thus, is it any wonder that the vibrations created by these prayers and meditations should render these places sacred? Thus, everything connected with this *Mela* brings the two worlds, spirituality and religion, to the fore.

Being fascinated by the grandeur of this *Mela*, Sidney Low, who visited *Kumbha* during the tour of the Prince and Princess of Wales in 1906, writes "*nothing more impressive, picturesque and pregnant with meaning and significant than the Kumbha Mela can be witnessed in India.*" Further he mentions "*Until you have looked upon one of these tremendous gatherings of humanity, many aspects of Indian life and character may be hidden from*

you...you see Hinduism at its best and its worst; you begin to realise faintly the hold that this jumble of devotion, metaphysics and rank idolatry has upon the masses of people; you observe Brahmanism working hand in hand with a crude and savage felish worship; you have before you such multitude of men and women as you may not meet twice in a life".

Location

The *Kumbha Mela* is generally held every three years by rotation at the four holy places, Prayag (Allahabad) (Latitude $25^{\circ}42'$N and Longitude $81^{\circ}50'$E),Hardwar (Latitude $29^{\circ}56'$N and Longitude $78^{\circ}11'$E), Ujjain (Latitude $23^{\circ}10'$N and Longitude $75^{\circ}41'$E) and Nasik (Latitude 20° N and Longitude 74°E). At the *Triveni Sangam* at Prayag, the *Ganga* is more than 2 Km wide and is shallower and more turbid than the *Yamuna*. The *Triveni* owes its name to the confluence of the *Ganga*, the *Yamuna* and the mythical *Saraswati* The *Mela* at Hardwar is held at the *Har Ki Pauri ghats*, on the bank of the *Ganges*. This is believed to be the spot, where the river leaves the mountains and enters the plains The place is also important because of a footprint on a stone there, believed to be that of Lord *Visnu* Ujjain, in Madhya Pradesh, about 60 Km from Indore, is on the right bank of *Sipra* river. The *Kumbha Mela* there is locally called *Simhastha*. Ujjain is also seat of the *Mahakaleshwar* temple, housing one of the 12 *Jyotirlingas* or *Siva* icons. In Nasik, Maharashtra, the *Mela* is held beside the *Godavari*. The city has about 200 temples and a number of bathing ghats, like Hardwar The Nasik fair is also called *Simhastha*. The location of the *Mela* sites is shown in Fig. 1.

Meaning and Form

The word *'Kumbha'* means "pot" and refers to the *Puranic* story of the pot of nectar that arose from the churning of the milk-ocean by the gods and demons. The term "*Kumbha*" finds its mention in our ancient scriptures,

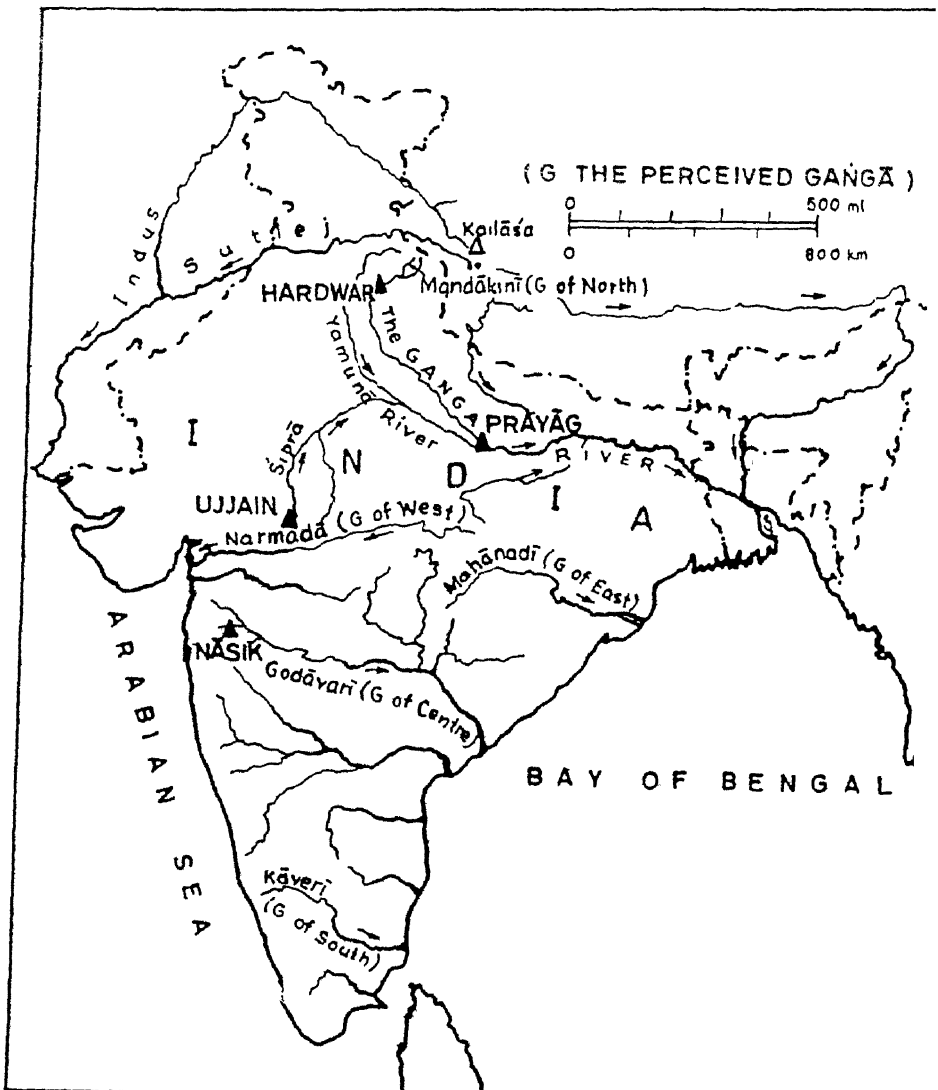


Fig. 1. *Spatial Pattern of Kumbha Site*

portraying different symbolic meanings viz indicator of global welfare, particularly when the conjugating Jupiter, Sun and the Moon are in Aquarius to sanctify the *Mela* sites[1], water supplier in drought[2]; endower of prosperity upon the earth[3]; a congregation of *Sadhus* gratifying the earth with their sermons[4], an act of giving a sigh of relief to the earth by accumulating noble deeds *(Punya)* and destroying the ignoble *(Papa)* ones[5], endower of prosperity and glory upon the earth[6]; and an annihilator of sins to bring about the global welfare[7]

1. कु पृथ्वी भावयन्ति भविष्यत्कल्याणदिकाय महत्याकाशे
   स्थिता· बृहस्पत्यादयो ग्रहाः सयुज्य
   हरिद्वार-प्रयागादितत्तपुण्यस्थानविशेषानुद्दिश्य यस्मिन् सः कुम्भ· ।
2 कं जल उम्भति पूरयति अवर्षणादिदुर्भिक्षेभ्यो दूरयतीति कुम्भ ।
3 कु पृथ्वीं उम्भति पूरयति मङ्गलसम्मानानादिभिरिति कुम्भ ।
4. कुः पृथ्वी उम्भ्यतेऽनुगृह्यते उत्तमोत्तममहात्मसङ्ग मैः
   तदीयहितोपदेशैः यस्मिन् सः कुम्भः ।
5 कुः पृथ्वी उभ्यते लङ्कुक्रियते पापप्रक्षालनैः पुण्यपरिवर्द्धनश्च
   येन स· कुम्भः ।
6 कुं पृथ्वी भापयति दीपयति तेजोवर्द्धनेति वाः कुम्मभः । (भातेणयर्थेः)
7. कुं पृथ्वीं भावयति पोषयति विविधयागादिभिरीति
   वा कुम्भः । (णयर्थेभुव.)

The *"Kumbha"* has been eulogized as - "On your emergence from the churning of the milk-ocean, you have been directly held by the Lord *Visnu*. In thy water, all the pilgrimages, gods, beings and souls are situated; you are an apparent representative of Lord *Siva*, *Visnu* and *Brahma* and an eternal abode of *Aditya, Vasu, Rudra*

and the Cosmic Father, the bestower of the *Karmika* results[8]

8 आदित्या वसवो रूद्रा विश्वदेवा सपैतृका ।
त्वयि तिष्ठन्ति सर्वेऽपि यत. कामफलप्रदा ॥

Symbolically, the *Kumbha* represents the whole of the universe, locating the situation of *Visnu* in its mouth, *Indra* in the neck, Mother goddess, in the center, *Brahma*, in the root; mountains, earth, oceans at the base, along with all the *Vedas*

कलशस्य मुखे विष्णु. कण्ठे रूद्र समाश्रित: ।
मूले त्वस्य स्थियो ब्रह्मा मध्ये मातृगणा: स्थिता. ॥
कुक्षौ तु सागरा. तु सागरा: सर्वे सप्तद्वीपा वसुन्धरा ।
ऋग्वेदोऽथ यजुर्वेद· सामवेदो ह्यथर्वण· ॥
अङ्गैश्च सहिता: सर्वे कलश तु समाश्रिता ।

The world we know is indeed derived from a higher one, the abode of truth, but at the same time a degraded form of it. Symbols have appealed to man since the dawn of thought broke out of its nightly sleep to remind him of the original form. Among such highly revelatory symbols the "*Kumbha*" is one, which filtered down the questful heart of man as a missionary of the veiled divinity, to convey His message. Thus, the term *Kumbha*, effectively stands for the Higher One and its *Amrit* for knowing Him

Origin

In the *Atharvaveda* it is mentioned that *Brahma* has designed the four *Kumbha Parvas* for the spiritual liberation and mundane pleasure of human beings.

'चतुरः कुमभांश्चतुर्धा ददामि' ।

(*Atharvaveda* 4.34.7)

The *Puranic* mythology links it with the churning of the milk-ocean and the subsequent scramble of the gods and the demons for the possession of the *Amrit* It is said that in this divine event, the "*Amrit Kumbha*" fell at the four *Mela* sites, sanctifying these for all time to come Since this event lasted for twelve divine days, (equal to twelve human years), this festival is celebrated in its commemoration at the interval of twelve years at these places Contrary to this view, the epics relate it with a different story, but connect the sanctity of the sites to the same effect as do the *Puranas* In addition to it, the *Puranas* relate the *Mela* to certain planetary configurations and periodicity. Moreover, on the basis of an analysis of the salient features of the *Kumbha*-holding sites, this *Mela* has also been related with the effect of Gangaization (the influence of the *Ganga* cult)

Antiquity

Although *Kumbha* finds its mention in the *Vedic* texts, it is controversial and not fully known when the *Kumbha Mela* crystallized in its present form, and who the real founder or the first organizer was.

Neither the *Dharma Sastras* nor any of the published *Puranas* mention the "*Kumbhasnanayoga*". No reference has so far been traced in any inscriptions or writings of early times about the holding of the *Kumbha Mela*. The Chinese pilgrim Huan-Tsang, who visited and stayed in India from 629 to 645 A.D. and is well known for giving copious details of what he heard and saw, and who stayed at Prayag for some time during the reign of King *Harshavardhan* (606-645 A D.), has not mentioned anything about the practice of holding *Kumbha Mela* at that place. He, however, describes a some what similar gathering at Prayag at the interval of every five years, in which the king, the people, the monks etc., used to participate. On the basis of this sketchy account, some scholars opine that *Harsha* was the initiator of this *Mela*. There is, however, no record of this practice continuing after

the death of emperor *Harsha* There are some, who believe that it was *Adi Guru Shankaracharya*, who gave final shape to this practice by the force of his magic personality. But, there is no indication of such an event either in the writings of *Shankaracharya* or his disciples or those of others However, the designation of the Prayag fair of 644 A.D as 'ageless' by Huan-Tsang indicates that such gatherings and the ritual bathing were in practice from early times in India. Roy (1956) designates this practice as *Maghisnana* and fixes the date for its beginning in Neolithic times According to him, the present form of the *Kumbha Mela* seems to have crystallized following the adoption of the solar calender from the Chaldeans in post-283 A.D

Planetary Configurations and Months

The particular year when the *Kumbha Mela* is held at any one of the four holy places is determined by reference to an almanac. At Prayag, the period is the *Hindu* month of *Magha* (January-February) and the highest merit attached is to the bath held on the new moon day, when the Jupiter is in Aries and both the Sun and the Moon are in Capricorn. At Hardwar, *Kumbha* is held in *Phalgun* and *Chaitra*, when the Sun passes to Aries and Jupiter is in Aquarius. The bath at Ujjain on the bank of the *Sipra* is fixed for the month of *Vaishakha*, when these planets are in Libra. At Nasik on the *Godavari (Narmada)* the function is timed to take place in *Shravana*, when the three planets are in Cancer. Thus, by rotation, the *Kumbha Mela* is held at these places. In the case of Prayag and Hardwar, in between two *Purna* (full) *Kumbha Melas*, an intermediate one, called the *Ardha* (half) *Kumbha* is also held. The *Ardha Kumbha Mela* is held at Prayag and Hardwar in the years in which *Purna Kumbha Mela* is held at Ujjain and Nasik, respectively. The *Ardha Kumbha Mela* is said to have originated at these places to preserve the existence of *Hinduism* against the onslaughts of the *Muslims*.

Every year in the month of *Magha* (January-February)

a fair, known as *Magha Mela*, is held at Prayag at the confluence of the *Ganga-Yamuna* and the *Saraswati* and is attended by thousands It begins on the *Makara Sankranti*, the last day of the preceding month *Pausa* Though there are certain special days, the entire month of *Magha* is considered to be sacred. The religious-minded people bathe at the *Sangam* daily, the chief bathing days are *Makara Sankranti, Pausa Purnima, Mauni Amavasya, Vasanta Panchami, Maghi Purnima* and *Maha Sivaratri*. The *Magha Mela* is replaced by *Kumbha Mela* every twelfth year, when the Sun is in Aries and the planet Jupiter in Aquarius (*Kumbha*).

Rituals

On the auspicious occasion of the *Kumbha Mela*, the *Hindu Sastras* ordain certain bathing norms to pilgrims They hold that on awakening from the night-sleep, one should devotedly recall the name of God and after freshing up, while making the posture of a *Kumbha* (pitcher), the pilgrims should go for holy dips while chanting the hymns of the occasion. Thereafter, being free from *Sandhyatarpanadi*, (some specific rituals to be performed in evening) one should establish a *Kumbha* to be worshipped with the concerned rituals of the *Kumbha* and those of Lord *Ganesha* in the days ahead Afterwards, a pilgrim should donate as per his capacity either one, four, eleven or twenty-one gold, silver or copper pitchers full of *Ghee* to any learned person. Observance of such rituals and baths in the *Kumbha Mela* is highly eulogized and is said to confer liberation from the cycle of life and death, and to earn salutation from the gods.

An unique feature of the Prayag *Kumbha* is that of the *Kalpavasis*, who present a scene of *Varnashrama Ashrama*. These *Kalpavasis* spend the whole month of *Magha* on the banks of the *Ganga* living an austere life in thatched huts, sleeping on sandy river beds, listening to discourses and giving alms. They bathe at the holy confluence thrice daily and eat only once in twenty-four hours.

According to *Srimadbhagavadgita,* and *Srimadbhagavata* days and nights of four thousand *Yugas* make an *Ahoratra* of *Brahma*, and is also known as a *Kalpa.* A stay although the above period in the world of *Brahma* is known as *Kalpavasa*

सहस्त्र युगपर्यन्तमहर्यद ब्रह्मणो विदु ।
रात्रि युगसहस्त्रान्ता तेऽहोरात्रविदो जना· ।।

(*Srimadbhagavadgita* 8.17)

त्रिलोक्या युगसाहस्त्र बहिराब्रह्मणो दिनम् ।
तावत्येव निशा तात यन्निमीलति विश्वसृक् ।।

(*Srimadbhagavata* 3 11.22)

According to *Bhagavata* only the gods are capable of accomplishing the feat of the *Kalpavasa* of *Brahmaloka,* for they alone are immortal and reside in a world of their own

देवान्भावयतानिन ते देवा भावयन्तु व. ।
परस्पर भावयन्तः श्रेय. परमवाप्स्यथ ।।

(*Srimadbhagavata* 3 11 22)

Man being mortal and in the physical body can neither reach *Brahmaloka* nor survive for the time period of one *Kalpa*. Under the circumstances, lest man should remain deprived of the benefits of *Kalpavasa*, according to the *Puranas*, there is provision for him at Prayag where he can get the same fruits, as may be attained through the *Kalpavasa* of *Brahmaloka*.

Scenes and Scenario

In the *Kumbha Mela*, religion, trade and amusement go

hand in hand The ground is dotted with tiny shrines, make-shift temples, thatched *Mandapams,* and *Ashramas* of innumerable sects of saints In the evenings and early mornings one may listen the *Nada* of *Kirtans*, citing of *Kathas*, chanting of hymns, jingling of bells, and blowing of conchs, and observe the scenes of millions of people taking a dip in the holy rivers with offerings of flowers, colourful ceremonials processions of various *Akharas* and the gatherings of saints and *Sadhus.* All these remind one the glory of ancient Indian traditions and culture, the faith of the people and their spiritual urge

The most distinctive and attractive feature of the *Kumbha Mela* is the ceremonial bathing of *Nagas* who are traditionally given priority in the bath for being the initiator of this festival The order of their precedence is fixed, based on the chronology of the origin of the various *Akharas.* According to Sarkar (1950), no reliable information is available about the origin of different *Akharas* before 1750 A D (*Akhara* means an organization of militant *Nagas* and points to a certain time period when the *Dasanami Sanyasins* took to arms) *Swami Sadananda Giri* (1979) mentions that the emergence of various *Akharas* seems to have occurred during Muslim rule. In lack of chronological records of the origin of different *Akharas* and rules on precedence before the 20th century, there occurred not only quarrels, but also regular pitched battles between different groups of *Nagas* on the occasion of the *Kumbha Mela* (Capt T Hardwick, 1976; Sarkar, 1950; Sidney Low, 1906). The British government, after inquiring into the age-long honoured practice, laid down the following rules, which are followed even today.

The precedence of baths at Prayag is as given below:

(1) The *Maha-Nirvani Sanyasi* along with *Atala Sanyasi;* the *Nirvanis* are *Gosains* and followers of *Siva.* They remain naked and have matted hair and each *Sanyasi* carries a bell. The members generally do not ask for alms;

(2) *Niranjani Akhara Sanyasis; Juna Akhara Sanyasis* along with *Ananda* and *Aahana Sanyasis* · (The *Niranjanis* are also worshippers of *Siva* and remain naked),

(3) *Bairagi Akharas:* (a) *Nirmohi* (b) *Degambaris* and *Nirvanis* They have three sects and are wandering *Sadhus;*

(4) *Nayapanchayati Udasina Akhara (Chhota Panchayati)* This body of *Udasins,* originally said to be *Sikhs,* later became *Hindus,* but continue to treat *Guru Grantha Sahib* of the *Sikhs* as their chief religious book,

(5) *Barapanchayati Udasina Akhara* (An off-shoot of the preceding *Akhara*), and

(6) *Nirmal Akhara* (known as *Nirmalis)* associated usually with *Nanaka Sahib* They also follow the *Guru Grantha Sahib.*

With the exception of *Bairagis,* the *Sadhus* of various *Akharas* march in great pomp, with a number of elephants and musicians, and carry their *Mahants* (religious heads) in palanquins.

At Hardwar, a little change takes place in the order of precedence, i.e. *Niranjanis* along with *Juna* and *Ananda Sanyasis* take bath first, and are followed by *Mahanirvanis* and *Atala Sanyasis.*

At Ujjain, the order followed at Allahabad is adopted, but at Nasik that of Hardwar is obeyed.

Merits of the *Parva*

The *Kumbha Parva* has been held in very high esteem in the *Rigveda,* and is believed to cleanse all sins and nullify the malefic effects of bad deeds of the past as well as of the present birth.

जधान वृत्र स्वधितिर्वनेव रूरोज पुरो अरदन्न सिन्धून् ।
विभेद गिरि नवभिन्न कुम्भभागा इन्द्रो अकृणुता स्वयुग्भि ॥

(*Rigveda* 10.89)

The *Suklayajurveda* mentions that this *Parva* provides all the mundane pleasures both in this life as well as in forthcoming births.

कुम्भोवर्निष्ठुर्जनिता शचीभिर्यस्मिन्नग्रे योन्यां गर्भोऽअन्त
पलाशिर्व्यक्तः शतधारऽउत्सो दुहे न कुम्भी स्वधा पितृभ्य· ॥

(*Suklayajurveda* 19 87)

In the *Atharvaveda*, as has already been said, it is mentioned that *Brahma* has designed the four *Kumbha Parvas* for the spiritual liberation and mundane pleasures of human beings

Meritorious Bath Occasions

As a riverside festival concerned with bathing rites, the *Kumbha Mela* has been eulogized much. The *Puranas* praise bathing at the confluence of the *Ganga*, the *Yamuna* and the mythical *Saraswati* in the month of *Magha* when the Sun is in Capricorn *(Makara).* Certain days are held in high esteem for this purpose; the fifteenth day of the dark half of the month being regarded as the month of the year, is considered to be the most significant. It is held that bathing in the river *Ganga* alone and in the *Sangam* of the *Triveni* leads to spiritual release, absolution of sins and cleansing of the soul . Bathing in river *Sipra* at Ujjain in the month of *Vaishakha* in general and on the full moon day of that month in particular is eulogized in the *Skanda Purana.*

प्रति कल्पामनुप्राप्य दृष्ट्वा देव महेश्वरम् ।
वैशाखे पौर्णमास्या वै स्नापयन्त्येकवासरम् ॥

(*Skanda Purana* 5 i(i)48 51)

माघवे मासि सम्प्राप्ते निमज्जन्ति नरोत्तमा· ।
न तेषा निरयनकिच्छिवरूपाश्चरन्ति ते ॥

(*Skanda Purana* 5 ı(ıı) 61 39)

अवन्तीयात्रा कर्तव्या प्रयत्नेन मुमुक्षुणा ।
माधवेऽपि विशेषेण ह्यवन्तीस्नानमाचतेत् ।
यो हि वैशाखमासाद्य अवन्त्यां व्यास ! मानवः ॥
सवत्सरव्रती स्नातस्तीर्थे यथाविधि ।
दत्त्वा दानानि सर्वाणि समूल फलमश्नुते ॥

(*Skanda Purana* 5.ı(ii)82 15b–17)

According to the *Siva Purana* and the *Varaha Purana* bathing in the river *Godavari* at Nasik is highly meritorious when the Sun and the Jupiter are in Leo.

गोदावर्यां सिंहमासे स्नायात् सिहबृहस्पतौ ।
शिवलोकप्रदमिति शिवेनोक्त तथापुरा ॥

(*Siva Purana* 1.12.22b–23a)

सिंहस्थे च गुरौ तत्र यो गच्छति समाहितः ।
स्नात्वा च विधिना तत्र पितृंस्तर्पयते तथा ॥
स्वर्गं गच्छन्ति पितरो निरये पतिता अपि ।
स्वर्गस्थाः पितरस्तस्य मुक्तिभाजो न सशयः ॥

(*Varaha Purana* 1.71.47–48)

The *Brahma Purana* says that three and a half crores of *Tirthas* that exist in the three worlds come for a bath in the river *Godavari* when Jupiter is in Leo and that bathing in the river *Bhagirathi* (the *Ganges*) everyday for sixty thousand years confers the same merit as a single bath in the river *Godavari* at that auspicious time

त्वां गौतमि सदा पूज्या सर्वेषामपि मुक्तिदा ।
विशेषस्तु सिहस्थे मयि त्रैलोक्यपावनी ॥
यानि कानि च तीर्थानि स्वर्गमृत्युरसातले ।
त्वां स्नातु तानि यास्यन्ति मयि सिंहस्थितेऽम्बिके ॥

(*Brahma Purana* 152.38–39)

तिस्र. कोट्योऽर्धकोटि च तीर्थानि भुवनत्रये ।
तानि स्नातु समायान्ति गङ्गायां सिहगे गुरौ ।
षष्टिवर्षसहस्राणि भागीरथ्यावगाहनम् ।
सकृद्गोदावरीस्नान सिंहयुक्ते बृहस्पतौ ।

(*Brahma Purana* 175.83–84)

Snanayogas

At the Hardwar *Kumbha*, there are three important *Snanayogas* (auspicious days for bath), the first being on *Sivaratri*, the second on the new moon day (*Amavasya*) of the *Chaitra* and the third on the first day of *Vaishakha* when Jupiter lies in Aquarius and the Sun in Aries. In the Prayag *Kumbha*, the first important bath is held on *Makarasankranti,* when Jupiter conjugates with Aries. The second and the most important bath is held on *Mauniamavasya* of the *Magha,* and the third on the *Basanta Panchami*. There is only one auspicious bathing day in the *Kumbha* of Ujjain, i.e. on the full moon (*Purnima*) of

Vaishakha, when the Sun moves to Aries and Jupiter enters into Leo There occurs three important *Snanayogas* (auspicious bathing periods) at the *Kumbha* of Nasik The first and the most important is in the month of *Shravana*, when Jupiter, the Sun and Mars enter Leo, the second being on the *Amavashya* of *Bhadrapada*, and the third is on *Kartika Ekadasi*. The *Mela* at Nasik lasts for four months According to *Sastrik* traditions, there is provision for four months *Vratas* to *Sanyasis,* that is, from *Shukla Ekadasi* of *Ashadha* to the *Shukla Ekadasi* of *Kartika*. On account of the above planetary positions, the *Melas* of Ujjain and Nasik are known as *Simhastha*

Administration and Management

A survey of historical records dealing with the affairs of the *Kumbha Mela* reveals that there has been a gradual upward trend in the number of pilgrims participating in the *Mela*. A retrospect into the past celebrations shows that Prayag *Kumbha* always ranked first in terms of the number of pilgrims participating in it The *Kumbha* at Hardwar, as a matter of fact, represents the 'Supra-regional' model attracting pilgrims from all over northern India from Kashmir to Bengal (Bhardwaj, 1985) The *Mela* at Ujjain ranks · third in importance, attracting pilgrims mostly from central India. The event at Nasik may be taken to be somewhat a local affair attended by only *Nagas,* a few saffron clad *Sadhus* and people from Maharashtra and Gujarat

To make this traditional event a success, management is made by both local and central administrative machinaries. However, during the past years many unpleasant events occurred in these *Melas* costing the lives of hundreds of pilgrims. The universal desire to bathe at the most propitious moment at the sanctified bathing spots has led to a great loss of life in times, and again. In 1820 at the Hardwar *Kumbha*, as a consequence of the desperate rush made by the infatuated crowd, 430 persons were crushed to death, including several sepoys deployed as guards. (Nevill, 1909). In

1950, on the main bathing day, despite elaborate arrangements, 22 persons lost their lives (Varun, 1981) When panic broke out among the crowd due to the confusion created during the procession of the ascetics about three hundred pilgrims were trampled to death into the muddy ground just below the bund at Prayag in 1954 (Krasa, 1965). The latest *Kumbha Mela* at Hardwar in 1986 also witnessed a similar heartrending stampede in which forty persons were killed and more than a hundred injured (Rudra, 1986) The number of the dead and injured was, however, far above the official figure

The crowds at the *Kumbha Mela* at present are larger than in the past, the facilities of transport coupled with the population explosion make the participation more intense. The management of the *Mela*, therefore, is not an easy task The problems of board and lodging, transport, sanitation, etc., have to be met by the local authorities Further, private bodies and voluntary organization also rise to the occasion to render all possible help to the pilgrims. The *Kumbha Mela* of Prayag, 1977, was planned on a lavish scale on an area of 2000 acres of sandy tracts. Elaborate arrangements were made for the regulation of traffic and for bathing at the confluence. The *Mela* ground had all the privileges of a modern township characterized by temporary hospitals, railway booking offices, post and telegraph offices, fire brigade stations, enquiry offices etc. Numerous tents and hutments were provided for the pilgrims on a grid pattern. Eight temporary bridges on the *Ganga* and one on the *Yamuna* were constructed for easy communication. Loudspeakers were installed at different corners and barricades were erected to facilitate one way traffic. Special trains were run and buses and private vehicles operated from all directions. Health facilities were appropriate and Cholera inoculation was made compulsory.

Similar arrangements were made by the administrative machinary to provide all possible facilities to pilgrims during the last *Kumbha Mela* at Hardwar in 1986. The

Mela ground was spread over 130 square kilometers encompassing parts of Saharanpur, Bijnor, Dehradun, Pauri Garhwal and Tehri Garhwal districts. The *Mela* region was divided into twenty sectors; and a sector magistrate, a deputy superintendent of police, regional health officer/officer-in-charge, medical services, were posted in each sector On the occasion of *Maha Kumbha,* 1989, at Prayag, rather more elaborate arrangements were made to make the *Mela* a success

Scope of the Present Study

An analysis of the genesis, symbols and benefits of the *Kumbha* indicates that the legendary *Kumbha Parva* and *Mela* named after it represent two different aspects of Indian life. The legendary *Kumbha* portrays the crystallized form of the spiritual process with a symbolic representation of different plexus and systems of body by the river, places and planets of the outer world. Hence, a purely socio-religious interpretation of its origin, antiquity and associated benefits may lead to erroneous conclusions. In the first part of the present study, an attempt has been made to deal in detail with the origin and antiquity of the twin aspect of the *Kumbha Parvas.* Moreover, the spirituality, as revealed by the *Kumbha Parvas,* has also been explained in the subsequent chapter.

The second part of the present study aims at introducing the audience about the celestial phenomena that variously affect the life and environment of our planet The world famous *Kumbha Mela* has been found associated with solar cycle, and its great bath, with lunar phases. This study shows that *Kumbha Mela,* held at different time and space, is based on the consideration of beneficial cosmobiological effects.

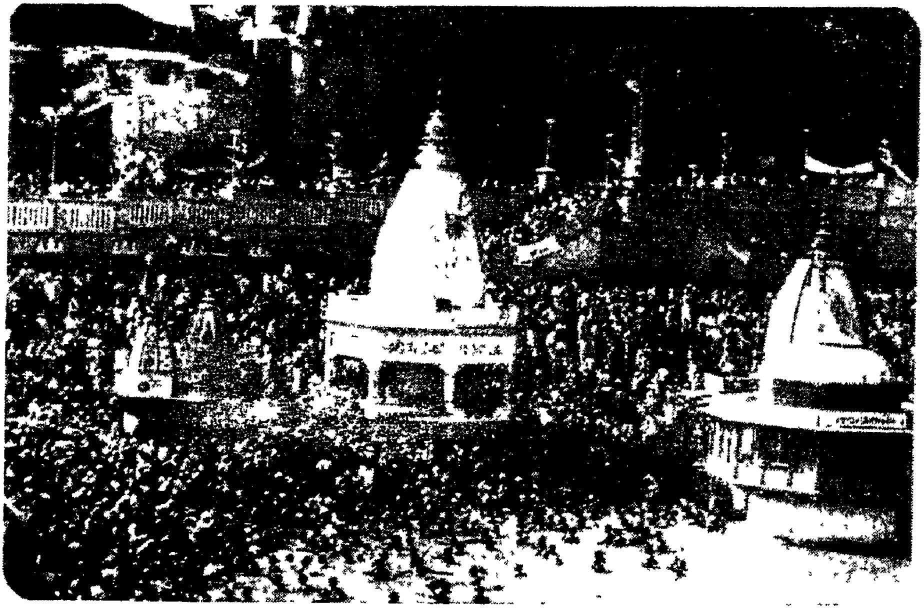


Fig. 2. *Bathing Scene, Hardwar*



Fig. 3. *Bathing Scene, Prayag*



Fig. 4. *Bathing Scene, Panchavati (Nasik)*



Fig. 5. *Main Bathing Site, Ujjain (Night Scene)*



Fig. 6. *Brahma Vaivart Kunda, Nasik*



Fig. 7. *Mela City, Prayag*



Fig. 8. *Pilgrims Performing Rituals*



Fig. 9. *Man Offering Water to Sun*

CHAPTER 2

ORIGIN AND ANTIQUITY

Introduction

It is a striking fact that the great mystics of India have all loved to speak in parables and fables and have dearly cherished our ancient legends. In the *Kumbha Mela*, many of the saints and sages rejoice in following this ancient tradition, a fact constantly evidenced by their discourses to the populace interspersed with stories and tales, canonical as well as apocryphal, to bring out to their audience the inner import and implications of spiritual injunctions and precepts. The historical myths seem to have been created as solutions to mysteries and legends to perpetuate such traditions. In course of time, these gends became traditions. The origin and antiquity of most Indian traditions are shrouded in deep obscurity. Hence in order to deal with the origin and the antiquity of the *Kumbha* - one of these age old traditions - a critical analysis of various evidences is highly essential.

The present chapter envisages to trace the origin and the antiquity of the *Kumbha*. Along with it, an attempt has also been made to trace the origin of the *Mahamakhan*. Which, on account of being similar, is

known as the *Kumbha Mela* of south India, a peninsular counterpart of the *Kumbha Mela* proper

Origin

Although the "*Kumbha*" finds its mention both in the *Vedic* and *Epico-Puranic* texts (*Rigveda* X 89 7, I.2 3 23, I.8 92, *Suklayajurveda* XIX 87, *Samaveda,* 6 3, *Atharvaveda* XIX 53 3, IV 34 7, XVI 6 8, *Mahabharata* I 25 ff, *Ramayana* III 35 27.34, *Garuda Purana* I 240 26-28, *Skanda Purana* IV i 50 55-125), there is no clear evidence regarding its origin

The above *Vedic* hymns merely indicate the spiritual implications of the *Kumbha* In the *Puranas,* the *Kumbha* has been mentioned as a holy place for the performance of death rites (*Vayu Purana* II.15 47), a place on the bank of *Saraswati,* where a holy bath is believed to bestow the benefit of *Yajna* performance, (*Naradiya Purana* II 65 100). From the above, it is clear that the *Kumbha* of the Vedas represents only spirituality, and that of the *Puranas,* the benefits from the ritual baths.

Regarding the origin of the *Kumbha* affair (*Amrit* and *Mela*) there are two main confounded traditions in vogue. one that links it with the mythological churning of the milk-ocean, and the other, which connects it with astronomical considerations. However, there appears to be one additional concept related to the impact of the river *Ganga.* In the following pages, an attempt has been made to analyse the above confounded traditions to trace the origin of the *Amrit Kumbha* and the *Mela* named after it.

Mythological Churning and the *Kumbha*

In many of the *Puranas,* not to mention the *Mahabharata,* we find the famous legend of the churning of the milk-ocean. In these scriptures, the ocean is taken to be the symbol of life in both of its aspects: potential and progressively evolving. Its archetype, the primal ocean, has been described by our sages as a boundless

stretch of hushed waters filling all space and in which, aeons ago, life had lain latent with Supreme Lord *Narayana* (trance) Then the trance broke and the One wished to project Himself into multiplicity *"Sokamayat Vahu Syam projayeyeti,"* *(Taittiriya Upanisad* 11.6) This started the cosmos in names and forms, vibrations and movements For exigencies of space, it is not possible to develop, far less to improvise speculatively, on this mighty theme Since we are not concerned with a detailed account of the colourful genesis of the creation, it is needless to dwell overmuch on it All we are directly concerned with is the post-cosmos condition of the world and coming into being of the first terrestrial ocean symbolizing life.

But, life once born, had to be helped to grow. So the *Devas* (gods) and the *Asuras* (demons), to expedite evolution, conferred together and decided to churn the ocean in order to extract the various boons it held deep-hidden in its womb The *Kumbha* has been linked with this mythological churning of the milk-ocean by the *Devas* and the *Asuras* to extract *Amrit* from it in order to become immortal, and the subsequent fight between them for the possession of the *Amrit Kumbha.*

The mythological story runs as follows· The *Devas* and the *Asuras* came to an agreement to churn the milk-ocean for recovering the many treasures that lay hidden under it, and more particularly to obtain the *Amrit,* on the understanding that the latter would be shared by both equally. This agreement seems to have been made because it was not possible for either party to do this mighty job alone As *Skanda Purana* mentions, for churning the ocean, the mountain *Mandara* served as the churn, the back of the *Kurmaraja* (tortoise-king), as the supporting base for this churning rod, and the serpent *Vasuki* as the rope required for the churning The churning commenced with the *Devas* holding the tail and the *Asuras* the mouth of the serpent *Vasuki.*

After many long years of churning, fumes, gases, fires, and then deadly poison emerged. In order to

rescue the agonized cosmos, Lord *Siva* quaffed the poison Thereafter arose, many valuable things, such as the flying horse, the milch cow, the priceless jewel, the magic moon, the sky chariot, the vibrant lyre, the *Rambha,* the siren; *Lakshmi*, the paragon of beauty, *Vishwakarma*, the architect, and so on till at long last, outsplashed *Dhanvantari*, the divine healer, broke the surface, holding in his arms the ultimate prize, the coveted *Kumbha* of nectar. He handed over this precious *Kumbha* to *Indra*, the king of the gods The *Asuras* immediately demanded a share of the *Amrit* The *Devas*, in- spite of the pact agreements made in the beginning, were now unwilling to share it with the *Asuras*, because they felt that if the latter drank this nectar, they would become immortal, and hence remain their invincible eternal enemy and would prevent any peace on Earth, which was the most undesirable The *Asuras*, however, on finding that the *Devas* are not willing to share the contents of the pot with them, snatched the *Kumbha* from the *Devas*. *Narayana* on seeing that the *Devas* had lost the nectar pitcher, assumed immediately the form of a female (*Mohini*) with wondrous beauty and charm and appeared before the *Asuras* who became enchanted by the fascinating beauty, and were tricked into loosening their grip on the *Kumbha*. The *Devas* availing of this opportunity, took the *Kumbha* from the *Asuras* and started drinking the *Amrit* *Rahu,* an *Asura*, perceiving this, assumed the form of a *Deva* and joined them in drinking the nectar. When the disguised *Rahu* had just sipped the *Amrit*, he was spotted by the Sun and the Moon, and they immediately informed *Narayana* about the deceit of *Rahu,* who immediately cut off the latter's throat with his shining *Sudarsana Chakra*. The *Amrit*, by that time had already descended *Rahu's* throat, and hence the upper part of his body containing the head and the throat became immortal and ascended towards the heaven The remaining lower part of his body sank below Henceforth, *Rahu* became the eternal enemy of the Sun and the Moon and whenever either of them happens to côme at any time in across his path he devours them and hid them in his

body But since his throat had been cut, the Sun and the Moon manage to escape his body through his throat after a while every time

Astrologically, *Rahu* (or its head) is the ascending node of the Moon's path or orbit in the sky and the upper portion of *Rahu*'s body, (which is believed to have ascended to the heavens) is that portion of the Moon's orbit that lies above the Earth's orbit, which is the Sun's path when observed from the Earth, and it lies above the plane of the ecliptic The lower part of *Rahu*'s body has come to be known as *Ketu*, and is the descending node of the Moon's path, and *Rahu's* body, which descended downwards, is that portion of the Moon's orbit, that lies below the Earth's orbit or the plane of the ecliptic Thus, it may very well be imagined that *Rahu*'s head is on the Moon's ascending node, and its feet (*Ketu*) are on the descending node, the two nodes being placed 180° apart The *Sudarsana Chakra* may be taken to mean the ecliptic- the glaring Sun's path in the sky which cuts the Moon's orbit into two parts, at points or nodes known as *Rahu* and *Ketu*. It is an astronomical fact that whenever the Sun or the Moon reaches the position of *Rahu* or *Ketu*, they are devoured, that is, eclipsed.

The removal of the *Amrit Kumbha* from the *Asuras* following the *Mohini's* spell of enchantment was detected by their preceptor *Guru Sukracharya* who alerted the *Asuras*. Realizing that they had been deceived by the *Devas*, the *Asuras* immediately started attacking them. There are different versions of what happened in the course of the tussle, but we are mainly concerned with a few that gave rise to the legend of the *Kumbha*. Finding the position of the *Devas* hopeless, *Brihaspati*, the preceptor of the *Devas* hinted to *Indra*'s son *Jayant*, the apparent heir of the heavenly kingdom, to flee with the *Kumbha* containing the *Amrit*, and hide it from the *Asuras*. In this act the Sun and the Moon rendered all help to *Jayant*, who changing himself into a rook, whisked away the *Kumbha* from the *Asuras* The *Asuras*,

seeing *Javant* running away with the *Amrit Kumbha*, started chasing him According to the version of the *Skanda Purana*, a fight ensued between the gods and the demons for twelve days in which the *Amrit* pitcher fell at four places, namely Prayag, Hardwar, Nasik and Ujjain Thus, these places got sanctified for all time to come, and the event led to the holding of the *Kumbha Mela* at these places According to another version, in course of the scramble, so as to avoid the *Kumbha* falling into the hands of the *Asuras*, *Jayant* hid it on the Earth at four different places, namely, Hardwar, Prayag, Ujjain and Nasik and this entire episode lasted for twelve divine days, equivalent to twelve human years. While taking the jar containing the *Amrit* from one place to another in a hurry on being chased by the *Asuras*, a little *Amrit* is said to have spilled over at these spots. This was how these places became so sacred, and led to the practice of holding of the *Kumbha Mela* only at these places.

Besides these, there are other versions in currency regarding the antecedents of this event It is held (Gauda, 1948, Roy and Indira, 1955, Dave, 1957, Krasa, 1965; Gupta, 1967; Bonazzoli, 1977, Saletare, 1981-82) that *Jayant*, while flying over the Earth, evaded the robbed now and then so as to be able to take rest *en route* to the Elysium and so descended from on high to perch at four different places viz. Prayag, Hardwar, Ujjain and Nasik. The magic touch of the *Kumbha* thus sanctified these places for all time and age, saints and pilgrims started periodically to flock to these holy sites to celebrate the divine event *Jayant* took twelve days to achieve his flight back to the safety of the paradise; so the pilgrims held the festival after every twelve years, presumably on the simple computation that what is a day to the gods is a year to the mortals According to the *Skanda Purana*, there are twelve *Kumbha Parvas*, celebrated in the commemoration of this divine event. Of which four are celebrated at the aforesaid places and the rest are celebrated in the realm of the

gods (in the *Devaloka*)

During the course of the scramble for *Amrit*, the Moon is said to have protected the *Kumbha* from spilling its contents, the Jupiter from the attack of the demons, the Sun from fragmenting and the Saturn from the threat of *Jayant*, lest he should devour the whole of its content *Jayant* either hid the *Kumbha* or it fell successively at Hardwar, Prayag, Ujjain and Nasik, *Brihaspati* (Jupiter), the *Devaguru*, who was all along guiding and rendering advice, was then staying in the heavens in the *Rasis* of *Kumbha* (Aquarius), *Vrisabha* (Taurus), *Simha* (Leo) and *Vrischika* (Scorpio), and hence in the beginning the practice is said to have begun by the holding of the *Kumbha Melas* at the aforesaid places at the time when *Brihaspati* (Jupiter) returns to the above *Rasis* in his twelve-year journey through them As the Sun along with his son Saturn, and the Moon were also on the vanguard in protecting the *Amrit Kumbha*, the festival is celebrated every twelfth year in a cyclic order, at the above places, only in the conjunction of these planets in the specific zodiacal sign Aquarius Alternatively, the period of stay of *Brihaspati* (Jupiter) in the above *Rasis*, is also taken into account in fixing the time for holding the *Kumbha Mela* and the auspicious days for taking bath in the holy rivers

There is a different story about the sanctification of these places It is said that *Garuda*, the vehicle of *Maha Visnu*, was given the task of carrying to *Devaloka/Visnuloka* the *Kumbha* containing the nectar on securing it after a long fight with the *Asuras*, while carrying this precious *Kumbha*, *Garuda* stopped *en route* at Hardwar, Prayag, Ujjain and Nasik and kept the *Kumbha* at these places for some time Thus these places became sacred, and the event led to the custom of celebrating the *Kumbha Mela*.

A somewhat different *Epico-Puranic* tradition is also in vogue. It is said that *Garuda* brought nectar from heaven to release his master *Vinata* from the bondage of the master of serpents *Kadru* He placed the pot of

nectar before the sons of *Kadru* and *Vinata* was released But *Indra* (or his son *Jayant*), stole away the pitcher and fled towards the heaven, upon being chased by the serpents. Four drops of nectar fell down from the jar on the aforesaid places, and hence these places gained the requisite significance for celebrating the *Kumbha Parva* (Giri, 1976). The second part of this story, i.e, the falling of the nectar at the four places is not found in any of the known *Epico-Puranic* texts (Bhattacharya, 1976-77), though *Garuda's* bringing of the nectar for his mother is mentioned (*Mahabharata* I.25ff., *Ramayana* III.35-27-34, *Garuda Purana* I 240.26-28 , *Skanda Purana* IV (i) 50 55-125).

It will be interesting to note that the story of the churning of the ocean is mentioned with some variations in both the *Ramayana* and *Mahabharata*, as well as a number of *Puranas*, e.g. *Visnu*, *Brahmanda*, *Padma*, *Bhagvata*, *Agni* and *Skanda* (Bedekar, 1967) but the episode relating to the spilling of the nectar at the four sites, is not found in any of these texts. It is said to be mentioned in some unpublished manuscripts of the *Skanda Purana*. The *Skanda Purana* as cited at the end has been said to be of comparatively recent origin, and, therefore, it seems that the *Jayant* story was added at a period much later than when the *Puranas* were written. The relation between the pitcher containing *Amrit* and the *Kumbha Mela* seems to be imaginary and fictitious. It appears that this *Epico-Puranic* legend, has been verbally grafted on the *Kumbha Mela* to relate it with hoary antiquity

Origin of *Kumbha Mela*

In veiw of the above, the *Kumbha Mela* seems to be exclusively related to ritual bath on the *Kumbhayoga*. As the religion geography of the *Mela* shows the impact of the *Ganga*, it seems likely that the former tradition was commenced to seek the bath benefits from the special water of the *Ganges*. The origin of the *Kumbha Mela* can be traced from the analysis of the above.

The mythological churning, therefore, suggests the origin of the *Amrit Kumbha* and the things connected with it, explains the process involved in *Kundalini Yoga* The grafting of macrocosmic elements and aspects relating the *Mela* over the mythologically represented microcosmic elements was designed to explain the subtle process through the *Mela*. The elements of macrocosm and microcosm represent one another as such. The *Triveni* i.e. confluence of the *Ganga*, the *Yamuna* and the *Saraswati*, at Prayag stands for meeting of *Ingla*, *Pingla* and *Susumna*. Different plexes and systems of the body taking part in *Kundalini Yoga* symbolize the places, planets, etc , of the macrocosm as such the brain to Hardwar, heart to Prayag, nave to Nasik, *Muladhara* to Ujjain, vibrating vertebral column to *Mandarachala*, *Muladhara* to tortoise, the support of *Mandarachala*, *Dhanvantari* seated in the heart, intellect in the brain to *Visvamohini*, the divine and demonic powers and propensities of man to gods and demons, *Rahu* and *Ketu* to *Raga* (attachment) and *Dvesa* (hatred), which eclipse the Sun (*Atma*) and Moon (*Mana*) and spiritual mentor (*Guru*) to Jupiter. The superstructures of the *Kumbha Mela* explaining the legends of the spirituality has been dealt with in detail in the next chapter.

Ganga and *Kumbha*

Darian (1978) leads us to believe from the analysis of the salient features of the *Mela* that it acts to enhance the grandeur and the sublimity of the life-sustaining river *Ganga*. Of the four places, where according to the legends the *Amrit* fell, two are located on the river *Ganga* itself - one at the foothill of the *Himalayas*, where the river enters the plains, and the other where it joins the river *Yamuna* and the invisible *Saraswati*. It is important to note that certain points along river courses used to have been worshipped and considered holy from the time immemorial. In the case of the *Ganga*, the most important contact points are at Hardwar and Prayag and the *Gangasagar* (*Matsya Purana* 105-154; *Padma Purana* III.43. 546-555; *Brahmanda Purana*, 77.3) The river

Godavari, on the banks of which Nasik is located, has been identified with *Ganga*, and has been named *Daksina Ganga* (South Ganga) (*Naradiya Purana* II 72 5 25) The sage *Gautama* is said to have brought the river *Ganga* there in the form of *Godavari*, hence it is generally referred to as *Gautami* (*Brahmanda Purana*, 74-76, *Naradiya Purana* II 72 11-12; *Vayu Purana* I 71 32-38, Kane, 1953) It is stated in the *Brahma Purana* (78-77) that to the south of *Vindhya* mountain *Ganga* is called *Gautami* and that's to its north is known by the name *Bhagirathi*. There is a temple on the *Ramghat* at Nasik, on the *Godavari*. The temple is opened after every twelfth year, when Jupiter is in Leo At that time it is presumed that the original water of the *Ganga* comes from the temple. In Ujjain, the river *Sipra* has been given added sanctity due to its flow in the northwardly direction (*Skanda Purana* V.1(I)63 7) This position is comparable with the northward flow of the *Ganga* in Kashi The *Ganga* is supposed to be more holy at places where its stream turns northward According to the *Skanda Purana* (V I(II) 42 27-29a), the *Sipra* becomes *Purvavahini* (flowing eastward) from the point where it was once embraced by the *Ganga* A *Linga* named *Gangesvara*, worshipped by the *Ganga* (*Skanda Purana*, V I (II) 42 29 bc, is found on the southern bank of the *Sipra* in Ujjain V (i) (ii) 42 24). Thus, the *Kumbha Parva* seems to be a ritual bathing festival, mainly associated with the river *Ganga*, both in its origin and its character The flowing water in its different forms is supposed to be an object of worship Although in early times divinity was associated with most rivers, the *Ganga* has been considered to be the holiest, for it being created by the three gods of the *Hindu* Trinity (Soloman, 1985) and made up of all *Tirthas*. The *Ganga* is supposed to be the archetype of the sacred water, with which other water bodies are compared ·in terms of sanctity This belief led to the process of *Gangaization* in the Indian culture (Singh, 1987) The sanctity of the *Ganga* became prominently established in India since the time of the composition of the *Nadistuti Sukta* of

Rigveda (X 75 5) It is supposed to confer immortality on its devotees. In the Indian religious set-up, the *Ganga* water is compared with the deathless liquid in its properties In support of this belief Darian (1978) has quoted an epic passage which exclaims "as *Amrit* is to gods, *Ganga* water is to men" (*Mahabharata* XIII 27 48 52) In Ujjain, the water of *Sipra* is also said to be endowed with the properties of ambrosia (*Skanda Purana* V I (II) 62 53) If so, the *Ganga* water might have been ambrosia to the unknown authors of the legend of the *Kumbha Parva* The *Kumbha* itself became one of the *Ganga's* most distinguishing sculptural manifestations This feature first appeared in the river goddess on the *Varaha* cave frieze at Udaigiri, dated around 400 A D , and became more and more common as the *Ganga* theme reached maturity in the Indian art during the medieval period. The *Kumbha* is a symbol of fertility, and it expresses several values, mostly related to the generative and the purifying powers of its water It may be taken as an expression of the *Ganga's* birth from *Brahma's* water-pot It may be possible that the pilgrims at *Kumbha Mela* draw any such connections From the above account it appears that the ritual bathing associated with the *Kumbha* owes its origin to the above mentioned considerations related to the holy "Mother *Ganga*"

Kumbhayoga **and** *Mela*

It is held that the *Mela* takes place only in the *Kumbhayoga* This astronomical conjunction is said to be of four kinds, each being associated with one of the aforesaid sacred places (Gaur, 1948). Without precise reference although some verses mentioned below, claim to be from the *Puranas,* and often quoted to show the validity of holding the *Kumbha Mela* at the specified times and places, there is no consensus of opinion regarding them. These four *Kumbhayogas* are given as below (Gaur, 1948):

(I) When Jupiter is in the sign of Aquarius and the Sun enters Aries, *Kumbha Parva* is held at Hardwar

(II) The *Kumbha Parva* is held at Prayag when Jupiter enters Aries and the Sun and the Moon are in Capricorn on the new moon day of the month of *Magha*

(III) When the Sun and the Jupiter lie in Leo, the *Kumbha Parva* is celebrated on the *Godavari*

(IV) The *Kumbha Parva* is celebrated at Ujjain, when Jupiter is in Leo and the Sun enters Aries.

Besides these, there are other alternative astronomical conjunctions that lead to the holding of *Kumbha* at Prayag, Nasik and Ujjain These are as follows (Gaur, 1948).

(a) When the Sun is in Capricorn and Jupiter transits into Taurus on the new moon day in the month of *Magha*, the *Kumbha Parva* is held at Prayag

(b) When the Jupiter, Sun and the Moon are in Cancer and it is *Amavasya* (new moon day), the *Kumbha Parva* is celebrated at Nasik

(c) When Saturn is in Libra and the Sun and Moon dwell together on the new moon day of *Vaisakha*, the salvation bestowing *Kumbha Parva* occurs at Ujjain

Although the above verses are usually ascribed to the *Skanda Purana*, these are not traceable in the extant edition of this *Purana*, suggesting an unknown origin. Though the authorship and the antiquity of the verses quoted above are uncertain, it appears that these may have been composed at the time when the tradition of the *Kumbha Parva* had already gained currency in India. While dealing with the *Kumbha Parva* in the "list of *Vratas*" Kane(1958) has not mentioned the source of his quoted verses *Kumbhayoga* and as such it also does not find any mention in any of the astronomical or astrological works. Even the Sankrit-English dictionary of Monier-Williams does not contain the word *"Kumbhayoga"*, though it mentions the names of several astronomical configurations. Thus, the *Kumbhayoga* seems to be a later interpolation. It is significant to note that the verses

generally referred to for holding the *Kumbha Mela* at Prayag, Nasik and Ujjain do not contain the term "*Kumbha*". The name "*Kumbha*" fits well only with the *Mela* at Hardwar The *Epico-Puranic* tradition about the origin of the *Kumbha Parva* shows that it should be celebrated at the specified places in the year in which there is a conjugation of the Sun, the Moon and the zodiacal sign Aquarius (Gaur, 1948).

It appears that the *Kumbha Parva* derives its name from an auspicious occasion of ritual bathing that used to take place at Hardwar every twelfth year when Jupiter was in Aquarius and the Sun transited into Aries. Such an astronomical conjugation is referred to in the *Naradiya Purana* (II.66 44) as a sacred time for bathing in the river *Ganga* at Hardwar. This suggests that the *Kumbha Parva* was originally observed only at Hardwar and was named after the *Kumbha Rasi* (Aquarius), for the festival occurs mainly at the time when Jupiter is in Aquarius, the latter represented in astrological illustrations as the water carrier. At Prayag, Nasik and Ujjain, the *Kumbhayoga* is not primarily connected with any celestial body being in the *Kumbha Rasi*. Therefore, the *Kumbha* festival at these places is technically a misnomer. The *Puranas* advise bathing in the *Ganga-Yamuna Sangama* at Prayag in the month of *Magha*, when the Sun is in the sign of Capricorn (*Makar*). Certain days are held in high esteem for this purpose and the fifteenth day of the dark half (that is the *Amavasya*) of that month is the month of the year, and hence very significant. The idea of holding the *Kumbha Parva* at Prayag may be attributed to the ritual bath on this day of *Magha*. It is held that this day of the *Makar Sankranti* month becomes doubly auspicious every twelfth year when Jupiter happens to be in Aries. Moreover, the first year, called *Prabhava* of the sixty year Jovian (*Barhaspatya*) cycle begins on *Magha Sukla* when the Sun and the Moon occupy the *Dhanistha Naksatra* and are in conjugation with Jupiter (*Vayu Purana* I.28.8 ; *Brihad Samhita* 8.27; Kane, 1958). It seems likely that in initiating *Kumbha Mela* at this place, this rare occasion

would have been taken into account and the *Mela* would have initially been termed the *Makar Kumbha Parva.* Similar traditions may lie behind the celebration of this *Parva* at Nasik and Ujjain It is said that ablutions in the river *Sipra* at Ujjain in the month of *Vaisakha* (April-May) in general and on the full moon day of the month in particular has been eulogized in the *Skanda Purana* (V I(I) 48 51. 61.39, V.I(II).82 15b-17).

According to the *Siva Purana* (I 12. 22 b-23a) and the *Varaha Purana* (I 71 47-48), bathing in the river *Godavari* at Nasik is highly meritorious when the Sun and the Jupiter are in Leo. The *Brahma Purana* mentions that three-and-a-half crores of *Tirthas* that exist in the three worlds come for a bath in the river *Godavari* when the Jupiter is in Leo, and that bathing in the *Bhagirathi* (*Ganga*) every day for sixty thousand days confers the same merit as a single bath in the river *Godavari* at this auspicious time. Similarly in the *Tristhalisetu* (TSSP, 130.35), it is stated that bathing in *Godavari* when Jupiter is in Leo is everywhere equal to bathing in *Jahnavi* (*Ganga*). Thus, there is a paucity of evidence to show that the *Melas* at these three places were called *Kumbha Melas* in the beginning. In the *Brahma Purana* (152.38), the *Mela* at Nasik has always been referred to as *Simhastha.* In view of it, this does not appear pertinent to designate it as the *Kumbha Mela.* Bhattacharya (1976-77) has suggested that the term *Kumbha* was prefixed to the *Melas* held at Prayag, Nasik and Ujjain, perhaps after the nomenclature of the *Kumbha Parva* of Hardwar As recorded in the various scriptures, the place, time and positions of the planets determining the *Kumbha Mela* are schematically represented in table 1. This table shows that the *Mela* occurs mainly on the conjunction of Jupiter with some specific constellations, and that the other factor, i.e. *Sankranti* (the point of time when the Sun leaves one zodiacal sign and moves to another) is not a determining factor. Between two *Kumbha Melas* comes the *Ardha Kumbha* of Hardwar and Prayag. For this division there is no *Sastrik* authority, except a solitary verse of doubtful

Table 1

Kumbha Mela

Year	Place	Hindu Month (Roman)	Position of Cosmic forces	Name of the Parva
0	Hardwar	Caitra (March-April)	Jupiter x Aquarius, Sun x Aries	Kumbha
3	Prayag	Magha (January-February)	Jupiter x Aries or Taurus, Sun & Moon x Capricornus	Kumbha
6	Nasik	Bhadrapada (August-September)	Jupiter x Leo, Sun x Leo or Sun x Moon & Jupiter x Cancer	Kumbha Kumbha
	Hardwar	Caitra	Jupiter x Leo, Sun x Aries	Ardha Kumbha
9	Ujjain	Vaisakha (April-May)	Jupiter x Leo, Sun x Aries or Jupiter & Sun & Moon & Libra	Kumbha
	Prayag	Magha (January-February)	Jupiter x Scorpio, Sun x Capricornus	Ardha Kumbha
12	Hardwar	Caitra (March-April)	Jupiter x Aquarius Sun x Aries	Kumbha

authorship As the table shows, the *Mela* is celebrated regularly at an interval of three years, starting from Hardwar and followed by Prayag, Nasik, and Ujjain, respectively It is true that the *Mela* at Prayag occurs after three years of that of Hardwar and the gap between the *Melas* of Prayag and Nasik is also of three years However, the interval between the *Melas* at Nasik and Ujjain does not confirm to this rule The *Melas* at these places are celebrated in the same year, differing in a time period of only two months or so. The year in which the *Kumbha Mela* at Ujjain falls in the month of *Vaisakha* (April-May), it takes place at Nasik in the month of Aug-Sept of the same year Sometimes, the *Mela* at Nasik occurs earlier than that of Ujjain In that case, the *Kumbha Mela* at Ujjain precedes that of Nasik in the next two years. The gap is, however, never of one full year of the Christian calendar, though the *Vikrama Samvat* may change.However, the order of precession is not fixed. The *Mela* at Nasik precedes the *Mela* at Ujjain for three consecutive terms, but the latter comes before the former as five times in a row This phenomenon may be attributed to the interlopings of Jupiter in Leo at these places. The Jupiter comes into Leo for a period of one year, once in every twelve years. The practice now is to hold *Kumbha Melas* at Ujjain and Nasik in the same year after every twelve years. On some occasions, there may be a difference of one year between the two *Kumbha Melas* due to the position of Jupiter in the concerned *Rasi* divisions, at the times laid down for holding the *Melas* at these places. However, the one held at Ujjain has gained more importance than that of Nasik, where the *Mela* has now become less significant. Of course, the *Kumbhas* at Prayag and Hardwar are deemed to be the primary ones, and draw far more ascetics, devotees, and pilgrims than those held at Ujjain and Nasik. It may be observed that originally *Kumbha Snanayogas* took place only when Jupiter was positioned in the Aquarius, Taurus, Leo and Scorpio *Rasis*, all of which are *Sthira Rasis*, and when the Sun is in Aries, Cancer, Libra and Capricorn, which are all *"Chara" Rasis*. There has been a

slight change in fixing the *Kumbha Mela* at Nasik, where it is now held when the Sun enters Leo *Rasi* A chart has been constructed showing all the *Kumbha Melas* that have been held right from 1915 A D to 1989 A D alongwith those that will be held in future and other relevant particulars that will be interesting to the readers. The *Kumbha Melas* at Nasik and Ujjain are designated as *Simhastha Kumbha*

There is no consensus of opinion regarding the theoretical basis of the cyclic nature of the *Kumbha Mela* According to some scholars (KM 8.21; KN,6) it occurs regularly every twelfth year at a sacred place. Others are of the opinion that unless the particular astronomical conjunctions come into existence, the *Parva* cannot be held They assert that the *Kumbha Parva* may be celebrated even in the eleventh or thirteenth year after holding the *Kumbha* of the earlier one. It seems that this *Mela* has not always followed the twelve year cycle, and that it may take place in the eleventh year or in the thirteenth year as well. This view finds support from the calculations of years pertaining to the *Melas* at Prayag shown in table 2. This anomaly is revealed to be due to the retrograde movement of the planet Jupiter and the time taken by it in revolving round the Sun; Jupiter takes 11 86 years for its revolution round the Sun (Kane, 1958) which is less than 50 days in twelve solar years ie. 4343 days. According to astronomical calculations, Jupiter moves one house further after every 84 years; hence, out of seven *Kumbha Parvas*, the first six occur every twelve year but the seventh one falls in the eleventh year. Thus, the practice of holding *Kumbha Mela* every twelfth year fails to meet the criterion set up by astronomical considerations and calculations

Antiquity

Besides the above, there are various other traditions behind the origin of the *Kumbha Mela*. Of these mention may be made of a few:

Table 2

Kumbha Mela

1. Hardwar : Mesa Sankranti							2. Prayag : Magha Amavasya				
V.S.	A.D.	Tithi		P_1	P_2	Dif. in Yrs.	V.S	A.D.	P_1	P_2	Dif in Yrs
1972	1915	Vk	30	10/24°	0/0°	12	1962	1906	1/6°	9/23°	12
1984	1927	Cs	15	10/28°	0/0°	12	1974	1918	1/10°	9/23°	12
1995	1938	Vk	13	10/2°	0/0°	11	1985	1929	0/11°	9/23°	11
2007	1950	Vk	11	10/6°	0/0°	12	1997	1941	0/15°	9/23°	12
2019	1962	Cs	9-10	10/10°	0/0°	12	2010	1954	1/23°	9/18°	13
2031	1974	Vk	7	10/14°	0/0°	12	2021	1965	0/23°	9/4°	11
2043	1986	Cs	5	10/18°	0/0°	12	2033	1977	0/27°	9/4°	12
2055	1998	Vk	2-3	10/22°	0/0°	12	2045	1989	1/2°	9/18°	12
2067	2010	Vk	30	10/26°	0/0°	12	2057	2001	1/7°	9/4°	12
2078	2021	Cs	1	10/0-1°	0/0°	11	2068	2012	0/7°	9/4°	11
2090	2033	Cs	15	10/5°	0/0°	12	2080	2024	0/12°	9/4°	12

3. Ujjain : Vaisakha Purnima					4. Nasik · Bhadrapada Amavasya				
V.S.	A.D.	P_1	P_2	Dif. in Yrs.	V.S.	A.D.	P_1	P_2	Dif in Yrs
2002	1945	$4/24^\circ$	$0/27^\circ$	12	1989	1932	$4/8^\circ$	$4/0^\circ$	12
2014	1957	$4/28^\circ$	$0/29^\circ$	12	2001	1944	$4/11^\circ$	$4/1^\circ$	12
2025	1968	$4/2^\circ$	$0/27^\circ$	11	2013	1956	$4/17^\circ$	$4/18^\circ$	11
2037	1980	$4/6^\circ$	$0/15^\circ$	12	2025	1968	$4/19^\circ$	$4/6^\circ$	12
2049	1992	$4/10\text{-}1^\circ$	$0/29^\circ$	12	2037	1980	$4/26^\circ$	$4/23^\circ$	12
2061	2004	$4/15^\circ$	$0/20^\circ$	12	2049	1992	$4/24^\circ$	$4/0^\circ$	12
2073	2016	$9/19^\circ$	$0/27^\circ$	12	2060	2003	$4/4^\circ$	$4/0^\circ$	11
2085	2028	$4/23^\circ$	$0/25^\circ$	12	2072	2015	$4/8^\circ$	$4/1^\circ$	12
2097	2040	$9/27^\circ$	$0/27^\circ$	12					
2101	2051	$4/0\text{-}1^\circ$	$0/29^\circ$	11					

P_1 : Position of Jupiter in Zodiac/degree

P_2 : Position of Sun in Zodiac/degree; Vk : Vaisakha Krisna

Cs : Caitra Sukla

As referred to by Pt Veniram Sharma Gaud (1948) *Sanaka-Sanandanadi's* used to assemble in early times at Hardwar and Prayag at the interval of every twelve years. It is held that this tradition ultimately crystallized into the *Kumbha Parva*. (b) It is generally held that there used to occur get-together of *Gurus* and disciples at these places in a cyclic period of twelve years and in course of time, such meetings of the *Yogis* were also attended by religious-minded people and this took the form of *Kumbha Mela* According to some, the *Kumbha Mela* is the religious council of saints, sages and seers. Thus, there are various and varied mythological traditions regarding the origin of the *Kumbha Mela*

From an analysis of the above data, it is clear that ritual bathing was prevalent from early times on which the astronomical schemes have been grafted from time to time. Of various auspicious bathing rites, *Maghi Snana*, due on being associated with the *Ganges* in the earlier texts, seems to be of earlier origin than the bathing customs associated with the other rivers. It appears likely that the *Kumbhasnanayoga* is a later elaboration of the *Maghi Snanayogas* The astronomical super-structures and the lunar phases associated with these *Snanayogas* reveal that ancient astronomers were aware of cosmobiological effects of solar cycles as well as lunar phases, for the various astronomical insight of ancient planetary configurations related to the *Parva* indirectly relate to the solar cycles.

It deserves metion that the *Ganga* water abounds in cynophage (Safferman and Morris, 1963) and bacteriophage (Twart, 1915) that protect her water from decomposition and infection. Moreover, it contains several useful minerals necessary for human health. In view of these, the *Ganga* water seems to have been equated with *Amrit* and the ritual bathings on it was planned to crop the benefit of the above properties.

A retrospect into history of the solar cycles and that of the *Kumbha Melas* reveals that the latter events

at the four places occur following the cycle of the former Various astronomical conjugations concerning the *Mela* represent various stages of solar cycle, recorded to cause cosmobiological effects and influence the environment of Earth Thus the grafting of the various astronomical configurations on these ritual baths seems to have been done as a solution to spatio-temporal cosmobiological effects of the planetary radiations Similarly, the holding of the important baths on new and full moon days seems to have been planned as a solution to bio-effects of lunar phases. For, water has capability to remember the imposed electromagnetic fields and can conversely overwrite the same of man in ritual bathings

Thus the *Kumbha Mela* primarily seems to be the expanded form of *Maghi Snana* tradition, originated in consideration of health benefits of the *Ganga* water, on which various astronomical configurations were grafted later on in the light of spatio-temporally varying bioeffects of planetary radiations and lunar phases, and it has nothing to do with the mythological legend dealing with the churning of the milk-ocean that ultimately led to the origin of the *Kumbha*.

Origin of *Mahamakhana*

It is generally believed that the tradition for holding the *Kumbha Mela* is confined only to the northern and the central India and that southern India is deprived of anything analogous to this glorious tradition. Contrary to this belief, the *Mahamakhana Parva* at Kumbhakonam in south India is comparable to the *Kumbha* festivals of the northern and central India and deserves to be designated as the *Kumbha* of the south. Just as the *Kumbha* festival is held at the interval of every twelve years at Hardwar, Prayag, Ujjain and Nasik, the *Mahamakhana* is also celebrated at every twelve years in the commemoration of *Kumbha* like mythological background. The origin of this fair is also rooted in mythology, suggesting its hoary antiquity. This fair is

also attended by millions of people coming from different ranks and faiths of the *Hindu* society Similar to the popular *Kumbha*, pilgrims here too take holy dips in the river *Kaveri* to get absolved their sins The main *Snanayoga* at this *Kumbha* occurs on *Pausa Purnima, Mauni Amavasya, Basanta Panchami, Maghi Purnima* and *Mahasivaratri* The *Snana* of the *Mauni Amavasya* is considered to be the most important, and it attracts highest gathering

Kumbhakonam (*Sanskrit-Kumbhaghosama*) is located near Chidambaram on the bank of the *Kaveri* As referred to by Ram Naresh (1989), the Kumbhakonam has also been referred to once in the *Padma Purana* In *Satadhyayi*, it is mentioned that the majority of sins that cannot be removed in the Kumbhakonam, can be removed in Kashi and the remaining in the Prayag. This establishes beyond doubt the *Sastrik* authority behind this *Parva*. Further, the presence of a pitcher-shaped *Shivalinga* at this place and its location near the ocean connects this *Parva* firmly to with the milk-ocean churning of the *Kumbha* tradition. The mythology about its origin runs as follows: A pitcher (*Kumbha*) was prepared by *Brahma* in which *Amrit* was kept. In the course of time, the neck of this pitcher got broken and some of its content spilled out and spread over an area about ten miles. This area thus became nectarized, and this sanctification led to the regular holding of *Mahamakhana Parva* i.e. the south Indian *Kumbha Mela*. The spilling and spreading of *Amrit* from this *Kumbha* is referred to in the *Tirthanka* of the *Kalyana* as follows:

> *Kumbhasya Ghonanto Yasmin Sudhapura Vinissrat Ama,*
> *Tasmata Tatpadama Loke Kumbhaghonam Vadantihi.*

As discussed above, the twin aspect of the *Kumbha* have their different origin, implying thereby of their different aniquity. In the following pages, an attempt has been made to deal with the antiquity of the *Amrit Kumbha* and of the *Kumbha Mela*.

Antiquity of *Amrit Kumbha*

It is to be indicated that the *Kumbha* with its different attributes finds its mention in the *Vedic* and *Epico-Puranic* texts. (*Rigveda* X 89 7; I.2 3.23; I 8.92, *Shukla Yajurveda* XIX.89, *Samaveda* 6.3; *Atharvaveda* XIX.53.3, IV 34 7, XVI,6 8, *Mahabharata* I.25.ff; *Ramayana* III 35.27-34; *Garuda Purana* I.240 26-28; *Skanda Purana* IV(i) 50-55-125) etc The *Vedic Kumbha*, however, indicate its spiritual significance, suggesting that its concept was fully crystallized by then. Although its perfection might have taken several hundreds of years, its earliest reference on being found in the *Rigveda* suggests that the latest date of the origin of *Amrit Kumbha* goes back to early *Vedic* age. Based on palaeoenvironmental evidences, Rai (1987) has fixed the lower limit of the *Rigvedic* age around ≥125000 years B.P. (before present) Therefore, the origin of *Amrit Kumbha* can be safely put around ≥ 125000 Years B.P

Antiquity of the *Kumbha Mela*

Although the term *Kumbha* finds its mention in the *Vedic* and *Epico-Puranic* texts, there is no reference to the *Kumbha Mela* as such. Further, neither the *Dharmasastras*, nor any published *Puranas* mention about the *Kumbha-Snanayoga*. No reference has so far been traced from any early inscriptions or from writings of the early periods about the holding of the *Kumbha Mela*. The Chinese pilgrim Huan-Tsang, who came to India in seventh century (629-645 A.D.) and is well known for his graphic accounts of what he saw and heard, nowhere mentions about the practice of holding the *Kumbha Mela*. He, however, mentions that in the sixth quinquennial assembly organized by King Harsavardhan about half a million people gathered around the confluence of the *Triveni* and that the ceremony lasted for a month. This was an 'agelong festival' in which the King Harsavardhan used to participate every fifth year of his reign. The pilgrims comprised people from almost all ranks of life from Emperor Harsavardhan with his ministers,

tributaries, chieftains down the beggar in rags Among the participants were heads of various religions, sects, as well as philosophers, scholars, ascetics and spiritual aspirants from all walks of life The Emperor performed all the rites with great eclat (Life, 186-187, On Yuan Chwang, I, I 364). This assembly apparently seems to have been arranged by the King to facilitate the intermixing of people from all strata of society, to bring about a synthesis of different schools of thought and culture, and to foster tolerance for all faiths and religions In addition, his intention seemed to help monks, ascetics and above all the Buddhist *Bhiksus*, as well as the poor and the needy with gifts of apparel and money. The date of this celebration was 644 A.D. From the accounts of this Chinese traveller some scholars have inferred that Harsha used to visit Prayag on the occasions of *Ardha Kumbha*, which still occurs after every five years (Roy and Indira, 1955, Gupta, 1967, Roy, 1969) It has also been presumed that Harsha did not initiate this fair, but only adopted it and gave it a royal fillip in order to promote religious fervour among the people There is, however, no record of this practice continuing after King Harshavardhan. Further, since Huan Tsang nowhere specifically describes it as the *Kumbha Mela*, such gatherings seem to have been *Maghi Mela* and not the *Kumbha*. As regards the present *Kumbha Mela*, it is believed that *Adi Guru Shankaracharya* (788-820 A.D.) gave the ongoing tradition of *Maghi Mela* the shape of the present *Kumbha Mela* by the force of his magic personality He first established the four well known monastries: *Jyotirmath* in the north, *Sringerimath* in the south, *Govardhanmath* in the east and the *Saradamath* in the west. Each of these centres, which he had created with the express purpose of advancing the cause of monotheism, was classified into ten orders: *Saraswati, Puri, Bana Tirtha, Giri, Parvat, Bharati, Aranya, Ashrama,* and *Sagara*. In each of these, he nominated a head, who was to guide the *Sadhus* under his charge. The latter were exhorted to assemble regularly at the *Kumbha Mela* with the two-fold purpose of maint-

aining contact with *Sadhus* of other denominations and fortifying the spiritual aspirants There is, however, no indication of the above either in the writings of the *Adi Guru* and his disciples or in the works of other scholars Thus, for the lack of any concrete proof it is difficult to say when exactly the *Kumbha Mela* crystallized into its present form and who was its first organizer To trace the antiquity of this fair, astronomical observations alone can provide any reliable information In dealing with the astronomical origin of this great bath, one encounters two problems first regarding the month long duration of the *Kumbha Mela*, and second, regarding the *Magha Snanas* on the *Maghi Amavasya*. These two problems are, from an astronomical view-point, totally different and hence should not be confused

From time immemorial, India has followed a sidereal lunar calendar (and astronomy) for reckoning time and religious observances In this calendar, the days are reckoned and the year deemed to be complete only when the Sun comes back to the same star after a complete round. The critical day for our purpose is *Maghi Amavasya*, i e., when the Sun and the Moon are both together near the star *Magha* (Regulas). The present Indian calendar was set in motion by *Visvamitra II* (viz. *Vessamette* of the *Suta dru Vipas* Valley, i.e., the main Harappan area) on the *Maghi Purnima* in 2382–2352 B.C. He took advantage of observations made one thousand years earlier in 3462 B.C., setting in motion the *Magha Snana* and after thirty years of personal observations made during approximately 2382–2352 B C. (see S.B.Roy, *Early Aryans of India 3100–1400 B.C.*, p 55), he found, among other things, that:

(1) the sideral year consists of 371 *Tithis*,

(2) the days of coloures (Equinox and Solstice) are advancing at the rate of one *Tithi* in 72 years (Intercalculations are made every third year, adding one extra month whenever necessary by observation). Simple, yet a portentious discovery, because the findings are integrally acurate, being correct to

parts per million There is nothing like this discovery in the whole of pre-Newtonion astronomy. Thus, *"Vessamette"* may be supposed to be the greatest astronomer of the ancient world. Based on *Visvamitra's* theory and his actual observations and analysis of the past records in ancient ways, Roy (1989) derives the following dates .

1939 A D. Winter Solstice at *Agrahayan Purnima*

859 A.D.: Winter Solstice at *Agrahayan Amavasya*

283 A.D.: Solar astronomy of *Chaldeans* adopted in India at *Mahasandhi* of the *Durga Pooja (Asvina Sukla* 8–9) by the eastern astronomers.

222 B.C.: Winter Solstice at the *Pausi Purnima*

1302 B.C.: Winter Solstice at *Pausi Amavasya* (observation by Lagadha; his disciple King Suchi initiates *Vedanga Jyotisa*).

2382 B C.: Winter Solstice at *Magha Purnima*; *Visvamitra II* completes his astronomy after 30 years of observations in 2352 B.C.

3462 B.C.: Winter Solstice at *Magha Amavasya*, pre-Harappan age. Observation probably made by some neolithic naked proto-astronomer at Allahabad. In commemoration of that event even today the naked *Sadhus* get the first preference at the "Great bath". It is perhaps a mechanically carry-over of the old tradition.

As the *Mela* depends upon the conception of the *Kumbha Rasi*, it was in all likelihood introduced in India when the Indian astronomy became solar at around 283 A.D. The *Mela*, therefore, can be post-dated and was probably organized by Emperor Harsha as the celebration of the *Maghi Snana*. The *Maghi Amavasya Snanas* (Great baths on the new moon day of *Magha*), on the other hand go back to hoary antiquity of the pre-Harrapan age, as has been shown above. From the above evidence, credit

goes to Emperor Harshavardhan for organizing the first *Kumbha Mela* on the eve of the *Maghi Snana*, the tradition of which was described by Huan-Tsang as an "Ageless Festival". It was *Adi Guru Shankaracharya* who transformed this local gathering (the proto-*Kumbha Mela*) into a pan-Indian assemblage of ascetics Thus, it was from the time of the *Adi Guru*, that the *Kumbha Mela* became more ecclesiastic, with sages coming to play a dominant role and the affairs of religion and society being discussed for necessary reforms at the confabulation by monks from diffrent parts of the country. The *Shankaracharyas* and later the *Dasnami Akharas* thus came to play their respective roles. The lay people responded enthusiastically, for they were given the twin options of winning fresh inspiration by consorting with the *Sadhus* and redemptive bathing in the sacred rivers

As regards the different astronomical combinations relevant to auspiciousness of the *Kumbha Mela*, it may be indicated that these may have been introduced by *Adi Guru* himself, as a solution to cosmobiological effects due to solar activity peaking in every twelve years. After the *Shankaracharya*, there are numerous recorded evidence of the *Kumbha Parva*. Sankar (1950) quotes a very important traditional piece of history which possibly refers to the celebration of the *Kumbha Parva* at Hardwar during the thirteenth century A D. This informs that *Naga Sanyasis* have won a decisive victory at Hardwar over *Bairagis*. Nevill (1909) records that in 1398 A.D. Timur massacred a large number of devotees at Hardwar *Kumbha*. The traditional history reports that *Chaitanya* has also attended *Kumbha Mela* at Prayag in 1515 A.D. (Ghurye, 1953). The *Parsee* religious text *Dabistani-i-Mazahib* (251) also records the *Kumbha Mela* of Hardwar during seventeenth century A.D. The *Gurucharitra* (III.50.33,99) of Gangadhar Saraswati a book written in Marathi about the end of the fifteenth century A.D. records the celebration of the *Simhastha Mela* at Nasik (Ghurye, 1953). The copper plate inscri- ption, in the possession of *Mahant* Radhamohanadasji of

Nasik, mentions a great massacre of *Bairagis* took place at Nasik at the time of *Simhastha Mela* in 1690 A D (Ghurye, 1953) The *Khulastu-t-Tawarikh* (folio 34b), composed in 1695 A.D., informs that every twelfth year when Jupiter enters the sign of Aquarius and the Sun is in Aries, large number of people assemble at Hardwar from remote distance for ritual bathing (Sarkar, 1901). The celebration of a festival on *Godavari* when Jupiter moves into Leo is also referred to in the same text (Khulas, Folio,33a, Sarkar, 1901). There is a record of pitched battle between *Shaivas* and *Bairagis* on the occasion of the *Kumbha Parva* in A.D 1760 to decide the dispute of precedence at that place (Nevill, 1909; Ghurye, 1953) There is also reference that on the question of precedence there occurred battle between *Nirvani* on one side, *Nirmohi* and *Digambari* on the other in Prayag *Kumbha* (Low, 1906, Pandey, 1955) The catholic character of this *Mela* seems to have crystallized during the *Bhakti* movement.

CHAPTER 3

SPIRITUALITY

Introduction

An analysis of various elements involved in the mythological evolution of the *Kumbha* and its different scriptural properties indicates that it represents the wholestic view of *Kundalini Yoga*, but with symbolic representation of various elements and centres of microcosm with their counterparts of macrocosm. The elements of macrocosm connected with the after-named *Mela* on the other hand, represent the prerequisites for the people to understand the counterparts of microcosm. Moreover, it needs to be emphasized that symbolic translation of planetary configuration into the *Mela* is based on considerations of cosmobiological effects, that have been dealt with in the next part This chapter is intended to analyze and deal with the inner import of various symbolic meanings attached with the mythological *Kumbha* and the after-named *Mela*.

The different attributes of *Mela* symbolically impress upon the multitude of humanity the need for gaining immortality through the churning of knowledge of "Self". Jupiter, Moon and Sun symbolically suggest that by concentrating the Mind (Moon) under the guidance of

Wisdom (Jupiter), the 'Self' (Sun) can be realized The holding of the *Purna* (full) and *Ardha Kumbhas* at the interval of every twelve and six years respectively symbolizes the need for purifying the body by sublimating the inherent vices of the twelve sense organs to arouse the six centres seperated from each other at the distance of twelve *Anguls* for attaining the *Amrit Kumbha.* These sense organs have been enumerated by Gupta (1967) as follows (a) *PANCKARMENDRIYAS* (five organs of action) annus, genitals, hands, feet and speech , (b) *PANCAJNANENDRIYAS* (five organs of perception) skin, tongue, eye, ear and nose The eleventh one is mind and the twelfth is the intellect Moreover, the above intervals for both the *Kumbhas* symbolically remind the aspirants that average time taken for gaining the *Amrit* (arousing the serpentine power) is twelve years and very occasionally it could be six years Hence, the *Ardha Kumbha* is celebrated at only two places, viz, Hardwar and Prayag The above periodicity of the *Mela* symbolically reminds the aspirants to recapitulate the practice to sustain the *Kundalini* longer in *Sahasrara*

As the *Vedas* state, we are the sons of *Amrit (Vayam Amritasya Putrah),* indicating thereby that since the dawn of thought man has been in quest of immortality. In the mythology, its process is symbolized by the churning of the milk-ocean by the gods and the demons Here, the gods and the demons represent the godly and the demonic forces always grappling with each other inside the man The victory of godly forces over the demonic ones, helps the churning of knowledge (*Amrit*) If this *Amrit* were not acquired, the demonic forces may lead the man to hell As we know, every man is endowed with *Amrit Kumbha*, located in between his eye brows and anatomically called pineal gland[1]. By churning the knowledge of self (Soul), nectar from this pitcher becomes available to man for attaining immortality and divine powers.

To fulfill the above quest of man, *Kumbha Parva* has

been designed, but with symbolic representation of elements of microcosm with their counterparts of macrocosm Everything connected with the *Kumbha* brings the two worlds - spirituality and scientific religion to the fore

In the mythological churning of the milk-ocean, Lord *Visnu* had to take four incarnations (a) as a tortoise to support the *Mandarachala* as churn, (b) as a patron of healing, *Dhanvantari*, upholding the *Kumbha* of *Amrit* in his hand, (c) as a Serpent *Vasuki* to run the churn, and (d) as *Visvamohini* (a form of woman with divine beauty) to cheat and entice the demon for making available the *Amrit* only to gods

The various components of the mythological story represent spirituality as such The *Ida, Pingla* and the spinal cord stand for the *Ganga* the *Yamuna* and the mythical *Saraswati* of the *Triveni* The *Muladhara* represents the tortoise and that of the nerves surrounding the spinal cord to the *Vasuki* and its tail to the *Kundalini* (serpentine power) The vibrating spinal cord symbolizes the running *Mandarachala* as churn in the process of arousing the serpentine power The brain, heart, nave and the *Muladhara* stand respectively for the Hardwar, Prayag, Nasik and Ujjain. A bath at the above four places leads one to *Moksa* In the heart, *Dhanvantari* is supposed to be situated and the intellect (Jupiter) in the brain denotes the fourth incarnation of Lord *Visnu* in the form of *Visvamohini*. The *Rahu* and the *Ketu* represent *Raga* (love) and *Dvesa* (hatred), which eclipse upon the *Atma* (Sun) and the *Mana* (Moon).

As indicated, the scriptural *Kumbha* represents the whole cosmos with marked situation of different elements, gods, etc. at various places. The human body itself is the representation of the much eulogized *Kumbha*. Of the four *Kumbhas* endowed upon man by Lord *Brahma* for attaining liberation, absolution of sins, etc. in fact stand for the four main subtle centres located at the *Muladhara,* nave, heart and brain in the human body. The meeting point of the *Ida, Pingla* and

spinal cord represents the physical *Triveni* (confluence of the *Ganga, Yamuna* and the *Saraswati*) A bath in it endows all the virtues as mentioned in the scriptures The subtle centres in human body are associated with different gods and elements Thus, holding the *Kumbha Parvas* rotating between the above four main centres at the interval of every three years and lastly bathing in the subtle *Triveni* opens the door for liberation of man

As a whole, the spiritual reflections and the attributes of the *Kumbha Parva* indicate the spirituality and that of the *Puranic* story deals with the process of arousing the *Kundalini* (serpentine power) In the following pages, it is attempted to deal with the *Kundalini Yoga* as ingrained in the *Puranic* mythological story related to the *Kumbha Parva*

All the *Tattvas*, cosmic principles, in creation are there embedded in the body. Each *Tattva*, however, has its own centre of activity, the place where it is most preponderant and from where radiate its energisings into the system. These all are locii called, in the *Tantras*, the centres or *Cakras* (circles) They are not, of course, anatomical locations detectable by the gross eyes. They are subtle centre-seats of self consciousness, *Sakti* active in the body and are situated within the spinal system beginning from the lower end of the spinal column up to the top of the brain The range of activity and influence of each centre extends to its corresponding region in the gross physical body-the various plexuses and cerebral centres From each of them radiate thousands of *Nadis*, conduits of *Pranic* force in different directions. These *Nadis* too are not to be confused with the nerves and arteries with which medical science is familiar They are subtle channels of the vital energies and are visible to the *Yogic Drsti* alone. They are, therefore, called the *Yoga-Nadis*. It is the configuration of these *Nadi* gives rise to the appearance of petals of lotuses, each with a different number of petals.

The principal *Nadis* are said to be fourteen in

number[2] Chief among them, however, are three *Ida, Susumna* and *Pingla.* Of these three, again the *Susumna* is the most important

The *Susumna* is situated within the spinal column, the *Merudanda,* in the interior canal, it extends from the *Muladhara,* the basic plexus, to the twelve-petalled lotus in the pericarp of the thousand-petalled lotus above Within this *Susumna* is a subtle *Nadi,* the *Vajrini,* and within it a still subtler one, the *Citrini* The interior of *Citrini* is called the *Bramha Nadi.* It is the channel for the movement of *Kundalini.* It is not a seperate *Nadi* in the usual sense, but only a *Vivara,* a hollow passage The opening of this *Citrini Nadi* is the door through which the *Kundalini* enters the Royal road, *Kula Marga,* on its way to the Lord and it is known as *Bramha-Dvara*

To the left of this *Nadi,* on the outside of the *Meru,* is the *Ida* and to the right is the *Pingla.* Both of them entwing the *Susumna* from left to right and right to left in the movement upward going round and the lotuses These are known as *Ganga (Ida) Yamuna (Pingla),* and *Saraswati (Susumna)* They all meet at the *Muladhara*[3] and again at the *Ajna Cakra* The meeting place at the *Muladhara* is the *Yukta Triveni.* The *Ajna Cakra* where they meet again and form plaited knot and enter the *Susumna,* - is the *Mukta Triveni.* Thereafter they separate and flow separately (hence called *Mukta Triveni*) and proceed in the different nostrils. It may be mentioned that *Ida* is also described as the Moon and *Pingla* the Sun, representing the negative and positive phases of the current activity

Muladhara

Midway between the genitals above and the anus below, at the place where the *Susumna Nadi* and the root of all *Nadis* (*Kanda*) meet, is the first centre, the *Muladhara Cakra.* The *Muladhara* lotus is said to be the subtle centre of this region, within the spinal column, with its head pointing downwards The colour of this lotus

appears crimson and it has four petals with the letters *Vam, Sam, Sam* and *Sam* upon them in gold Each of these letters is a *Mantra*[4], a *Sakti* and as such a, *Devata* attending upon the principal *Devata* of *Cakra* These letters constitute together the *Mantra*-body of the *Kundalini* The *Tattva* of which this letter is the centre of the *Prthvi*, Earth, whose form is a square and colour yellow Its *Bija* (seed) *Mantra* is *Lama* The *Lama* is a *Vaikhari*[5] sound expressive of the subtle sound produced by the vibration of the particular forces active in this centre The *Mantra* is said to be seated on an elephant-*Airavata* (the elephant depicting qualities of the reigning *Tattva*, strength, firmness and solidity) This elephant is also said to be vehicle of *Indra*

The *Devata* of the centre is the creative *Brahma*, whose *Sakti* is said to be *Savitri, Sakti, Dakini,* is also said to be here She is the *Sakti* of *Dhatu,* bodily substance of this centre She is regarded as revealer of the *Tattva-Jnana,* knowledge of *Tattvas*

Further, here is the *Yoni*, the *Triangle* - *Sakti Pitha* in which is the *Sivalinga*, called *Svayambhu* with the shape of a tender leaf This stands for the aspect of *Brahmana* manifested in the centre Its colour is yellow The *Devi Kundalini* luminous as lightning, shining, in the hollow of this lotus like a chain of brilliant lights, the world-bewilderer, who maintains all breathing creatures, lies asleep coiled three and a half times round the *Linga*, covering with Her head the *Brahmadvara*.

Svadhisthana

Next above, at the root of genitals is the *Svadhisthana Padma*. Unlike the *Muladhara,* which is situated at the root of the *Susumna,* this *Cakra* is placed within the *Susumna Nadi*. This lotus is vermilion colour and has six petals, with the letters *Bam, Bham, Mam, Yam, Ram* and *Lam*, shining like lightning The regnant *Tattva* of this centre is *Ap*, water, and hence the *Cakra* is known as the white region of the deity of ocean-*Varuna* The salient

form or *Mandala* of this *Tattva* is the cresent Moon and the colour white

The *Bija* is *Vam* and this *Varuna Bija* is said to be seated on a white *Makara* (animal like an alligator), that is the vehicle of *Varuna* The presiding deities of this centre are *Hari* (*Visnu*) and *Rakini*

Manipura

Above this, at the centre of the naval region, is the *Manipura* or the *Nabhi Padma* of dark hue (like heavy-laiden rain clouds) It is of ten petals with letters *Ḍam, Ḍham, Ṇam, Tam, Tham, Dam, Dham, Nam, Pam, Pham,* in the colour of blue lotus Its *Tattva* is *Teja* and the form is triangle with red colour This *Padma* owes its name *Manipura*, because it is lustrous as a gem, *Mani,* due to the presence of *Tejas* The red *Bija* of fire *Ram* is seated on a ram, the vehicle of *Agni* The *Devatas* that preside here are *Rudra*, and *Sakti Lakini* These three centres mainly form the gross body

Anahata

Further up, in the heart region is the lotus called *Anahata Padma* It owes this name because here the *Yogin* first hears the *Sabda Brahman*, the sound that is produced without the striking of the two things together, *Anahata* which is the usual occasion for any sound. This lotus of the colour of the *Bandhuka* flower has ten petals with letters in vermilion, *Kam, Kham, Gam, Gham, Ngam, Cam, Cham, Jam, Jham, Jnam, Ṭam, Ṭham* This is said to be abode of the *Jivatman* called the *Hamsa. Tattva* is *Vayu*, and its form is hexagonal-two triangles with one of them inverted and colour smoky-gray The *Vayu Bija* is mounted on a black antelope (whose chief quality is speed), the vehicle of *Vayu. Isa,* the overlord of the first three centres and *Sakti Kalini* are here

The downward oriented triangle (a form of *Sakti*) *Siva* as the *Bana Linga.* The distinctive feature of this

lotus's filaments are tinged with the rays of the Sun The *Anahata* is discribed as the great *Cakra* in the heart of all, *Omkara* is here

This lotus is to be discerned from the heart lotus of eight petals, which is situated below it As a matter of fact, that is not a *Cakra* but a lotus turned upwards *Ananda Kanda* in which one meditates upon the *Ista Devata* in *Manas Puja*, mental worship

Visuddha

Visuddha Cakra is located at the spinal centre at the base of the throat It is called so, for the *Jiva* has attained purity by the sight of the *Hamsa* It is also known as the *Bharati Sthana* (abode of deity of speech), for it governs the power of expression This lotus is of sixteen petals in smoky purple with the syllables *Am, Ām, Im, Īm, Um, Ūm, Ṛm, Lrim, Lrīm, Em, Aim, Om, Oum, Aṁ, Ah,* in crimson. The governing *Tattva* is ether or *Akasa,* its colour is white and is of circular in form. Its *Bija* is *Ham,* seated on a white elephant Here lies *Sada-Siva* in his form of *Ardhanarisvara,* i.e., inseparably united with *Girija* or *Gauri*, with half the body white and other half in gold; so also here dwells *Sakini,* the *Sakti*, whose form is light. It is here that the *Jnanin* becomes *Trikaladarsi,* seer of the three forms of time.

At the root of the palate, a minor *Cakra*, *Lalana* or *Kali Cakra*, a red lotus with twelve petals, is also supposed to be located

Ajna

Still higher up is the *Ajna Cakra.* It is called thus because here is received from above the command, *Ajna,* of the *Guru,* who is none else than the Lord *Siva*. It is located in between the two eye-brows. This lotus has two petals, white in colour, on which are white letters *Ham* and *Ksam*. *Manas* is the *Tattva* of this centre, or to be exact, this centre is the seat of the subtle *Tattvas* of

Mahata and *Prakriti*. The *Bija* is *Pranava, Om*. In this bright form of *Pranava* shines the *Antaratma*, the inner *Atma*, lustrous like a flame - and in its light is visible all that is between the *Muladhara* and the *Brahmarandhra* The ruling deities are *Parama Siva* (in the form of *Hamsa*) and the white *Hakini Sakti*. Here in the inverted triangle, *Yoni*, within the pericarp of the lotus, is *Siva* as the *Itara Linga*.

Above this *Cakra* are said to be located two minor ones.

(1) *Manas Cakra*· Lotus of six petals, the seat of sensations of hearing, touch, sight, smell, taste and centrally initiated sensations in dream and hallucinations

(2) *Soma Cakra* It is a lotus of sixteen petals, which are also known as sixteen *Kalas*, which are so many *Vrttis*

Above is the region of the casual body. Above this last *Cakra* is the house without support (*Niralambapuri*), where *Yogis* see the radiant *Isvara*. Above this is the *Pranava* shining like a flame, and above *Pranava* the white cresent *Nada,* and above this last the point, *Bindu*. There is then a white lotus of twelve petals with its head upwards and over this lotus there is the ocean of nectar (*Sudha Sagara*), the island of gems, (*Manidvipa*), the alter of gems (*Manipitha*), the forked lightning like lines, *A*, *Ka, Tha,* and therein *Nada* and *Bindu*. On *Nada* and *Bindu*, as altar, there is the *Paramahamsa* and the latter serves as an altar for the feet of the *Guru*; there the *Guru* of all should be meditated. The body of the *Hamsa* on which the feet of *Guru* rest is *Jnanamaya* the wings *Agama* and *Nigama*, the two feet *Siva* and *Sakti,* the beak *Pranava*, the eyes and throat *Kama-Kala* (*Introduction to Tantra Sastra*, by Sir John Woodroffe).

Beyond, there is the *Sahasrara*, the white lotus of one thousand petals each of which contains all the letters of the alphabet and is said to be own abode of

Para-Siva It swings with head downwards from the *Brahmarandhra* above all the *Cakras* It is said to be *Brahmaloka*, whence all originates This place is taken to be *Saiva-Sthana* by *Saivas, Paramapurusa* by *Vaisnavas, Devi-Sthana* by *Saktas.*

Above (the end) of the *Susumna Nadi* is the lotus of a thousand petals, it is white and has its head downward turned, its filaments are red The fifty letters of alphabet from *A* to *La,* which are also white, go round its thousand petals twenty times On its pericarp is *Hamsa* and above it is the *Guru* who is *Param-Siva* Himself Above the *Guru* are the *Surya* and *Candra-Mandalas*, and above them *Mahavayu.* Over the latter is placed *Brahmarandhra,* and above it *Mahasankhini* In the *Mandala* of Moon is the lightning-like triangle within which is the sixteen petal *Kala* of the Moon (*Ama Kala*), which is fine as the hundredth part of the lotus-fibre, and of a red colour, with its mouth downward turned In the lap of this *Kala* is the *Nirvana Kala,* subtle like the thousandth part of the end of a hair also red and with the mouth downward turned Below the *Nirvana Kala* is the fire called *Nibodhika* which is a form of *Avyakta-nada* Above it (*Nibodhika*) and within *Nirvana Kala,* is *Para Bindu,* which is both *Siva* and *Sakti* The *Sakti* of this *Para Bindu* is *Nirvana Sakti*, who is light (*Tejas*) and exists in the form of *Hamsa (Hamsarupa),* and is subtle like the ten-millionth part of the end of a hair. That *Hamsa* is *Jiva.* Within the *Bindu* is the void (*Sunya*), which is the *Brahmapada*, place of *Brahmana* (*The Serpent Power*).

Each of these *Cakras* represents a particular *Tattva* with a *Tanmatra* and the *Indriya* (sensory and motor organs) connected with it These are as follows .

MULADHARA — *Prthvi Tattva* (Earth) *Gandha Tanmatra* (Smell) *Jnanendriya* of smell *Karmendriya* of feet

SVADHISTHANA	*Ap Tattva* (Water) *Rasa Tanmatra* (Taste) *Jnanendriya* of taste *Karmendriya* of hands
MANIPURA	*Tejas Tattva* (Fire) *Rupa Tanmatra* (Sight) *Jnanendriya* of sight *Karmendriya* of anus
ANAHATA	*Vayu Tattva Sparsa Tanmatra* (Touch) *Jnanendriya* of touch *Karmendriya* of genitals
VISUDDHA	*Akasa Tattva Sabda Tanmatra Jnanendriya* of hearing *Karmendriya* of mouth
AJNA	Subtle *Tattvas* of mind *Prakrti*

In several attempts to identify these *Cakras* and some of the plexus in human body, it was found that the plexuses belong to the gross physical body and while the *Cakras* are subtle vital centres of conscioussness and have no any relationship with the plexus as such The *Cakras* are, in fact, locii, special centres, of operation of the *Tattvas* which are the self formation of the *Sakti*, they influence, vitalize and control corresponding regions of the body, and the organs, nerves, plexuses, etc situated in them

Each of the *Cakra* is associated with a deity, a particular form of consciousness-presiding over it And each deity has its own abode, *Loka*, as given below

CAKRA	*DEITY*	ABODE *(LOKA)*
Muladhara	*Brahma*	*Bhurloka*
Svadhisthana	*Rudra*	*Bhuvarloka*
Manipura	*Visnu*	*Svarloka*
Anahata	*Isvara*	*Janaloka*
Visuddha	*Sadasiva*	*Tapoloka*
Ajna	*Sambhu*	*Maharloka*

The *Sahasrara*, above the six centres, is the place

of *Parama Siva*, whose abode is *Satyaloka*

The *Tattvas* centred in the centres are the subtle forms of the respective *Devatas.* These *Tattvas* are said to be form both the gross human body and the universe - the macrocosm Hence, these *Cakras* may be taken as the divine subtle centres of the corresponding physical and psychical sheaths

The supreme, therefore, descends through its manifestations from the subtle to the gross as the six *Devas* and *Saktis* in their six abodes in the world-axis, and as the six centres in the body axis or spinal column The special operation of each of the *Tattvas* is located at its individual centre in the microcosm But, notwithstanding all such subtle and gross transformations of and by *Kula Kundalini*, she ever remains in Her *Brahman* or *Svarupa* aspect the One, *Sat*, *Cit* and *Ananda* as is realized by the *Yogi* when drawing the *Devi* from Her world abode in the earth centre (*Muladhara*) he unites her with *Para-Siva* in the *Sahasrara* in that blissful union which is the Supreme Love (*Ananda*) (*The Serpent Power*).

With regard to the letters which are on the petals of the lotus, in his brilliant exposition, the same author explains.

"Each object of perfection, whether gross or subtle has an aspect which corresponds to each of the senses It is for this reason that the *Tantra* correlates sound, form and odour Sound produces form, and form is associated with colour *Kundalini* is a form of the Supreme *Sakti* who maintains all breathing creatures. She is the source from which all sounds or energy, whether as idea or speech, manifests That sounds or *Matrka* when uttered in human speech assumes the form of letters and prose and verse, which is made of their combinations And sound (*Sabda*) has its meaning - that is, the objects denoted by the ideas which are expressed by sound or words. By the impulse of *Iccha Sakti* acting through the *Prana Vayu* (Vital force) of the *Atma* is produced in the

Muladhara the sound power called *Para*, which in its ascending movement through other *Cakras* takes on other characteristics and names (*Pasyanti* and *Madhyama*), and when uttered by the mouth appears as *Vaikhari* in the form of the spoken letters which are the gross aspect of the sound in the *Cakra* themselves Letters when spoken are, then, the manifested aspect in gross speech of the subtle energy of the *Sabda-Brahmana* as *Kundalini* The energy which produces these letters manifesting as *Mantras* produces the gross universe In the *Cakras* is subtle *Sabda* in its states as *Para*, *Pasyanti* or *Madhyama-Sakti*, which when translated to the vocal organ assumes the audible sound form (*Dhvani*) which is any particular letter Particular form of energy of *Kundalini* are said to be resident at particular *Cakra*, all such energies existing in magnified form in the *Sahasrara* Each manifested letter is a *Mantra* and a *Mantra* is the body of a *Devata* There are, therefore, as many *Devatas* in a *Cakra* as there are petals, which are surrounding (*Avrana*) *Devatas* or *Saktis* of the *Devata* of the *Cakra* and the subtle element of which, He is the presiding consciousness Thus, *Brahma* is the presiding consciousness of the *Muladhara* lotus, indicated by the *Bindu* of the *Bija La (Lam)*, which is the body of the earth *Devata*, and sound associated with these are subtle forms of the *Mantras*, which constitutes the petals and the bodies of the associated energies. The whole human body is, in fact, a *Mantra* and is composed of *Mantras*. These sound power vitalize, regulate, and control the corresponding gross manifestations in the regions surrounding them" (*The Serpent Power)*.

The *Sakti*, the fundamental power, which bases and governs each human organism is variously called the *Kula-Kundali, Kundalini, Kutilangi, Bhujangi, Isvari,* etc. It lies coiled up (three and half times) in the *Muladhara* with its mouth closing the entrance to the *Susumna*, the *Brahmadvara*, door to *Brahma*. The *Nada Sakti* in the body and all the *Mantras* are Her formulations. The six centres are the manifestations of this creative power. The *Prana* is a particular manifestation of this

Kundalini Sakti and the process of awakening Her begins with a concentrated stress on *Prana* The exact process may be learnt from the *Guru*

On arousing, as the *Sakti* darts upward it strikes against each of the lotuses which then bloom upwards This is the famous *Cakra Bheda*, the piercing of the centres Advancing from centre to centre, the *Sakti* swallows up the *Tattvas* that are embodied or concentrated in them Each *Tattva* is absorbed in the next subtler *Tattva* (which is said to be its immediate cause) and all are dissolved into *Cid-Atma*

In Her progess upwards, while absorbing in Herself the twenty three *Tattvas* commencing with the gross elements, and remaining Herself *Sakti* as consciousness, the cause of all *Saktis,* She unites with *Paramasiva* whose nature is one with Hers On their union nectar (*Amrit*) flows, which in ambrosial stream runs from the *Brahmarandhra* to the *Muladhara* flooding the *Ksudra Brahmanda,* or microcosm, and satisfying the *Devatas* of its *Cakras* It is then the aspirant (*Sadhaka*), forgetful of all in this world, is immersed in ineffable bliss

But the *Kundalini* does not stay in the *Sahasrara* for long. There is always a natural tendency to return to its natural position The *Yogi* has to repeat the process of ascent and descent again and again, strive to retain Her above for longer and longer periods till the *Sakti* stays permanently with the Lord, - returning only when so willed (by the *Yogi*), that is, till the union is complete and the liberation attains its full form

Thus *Puranic* legend symbolically cites the celebration of this spiritual *Kumbha*, which only can provide liberation from the chain of life and death. Since the human body represents the microcosm, in the process of arousing the serpentine power, all the *Kumbha* holding sites of which the four of *Mrtyuloka* and the remaining eight of *Devaloka* of the *Puranas*, get celebrated in the human body itself. Experiences have shown that the entire process leading to the attainment of *Moksa* takes

a time slit of twelve years The religious *Kumbha* at the four sites has been provisioned at the interval of every twelve years in the commemoration of this divinity attaining event

Notes

1 The key role to our seasonal behaviour lies in a tiny knob of the tissues buried deep inside our brain It is called the pineal gland and it rests beneath the cerebrum, down almost on the brain stem, between the thalamus and the mid-brain structures of the limbic system In a very real sense, this represents our "third eye" in the middle of our brain that sees without vision The pineal structure in humans does not sense light but receives nerve signals that originate in the retina of the eyes In effect, the brain has two optical systems, the one we are familiar with, for vision, and another one that- stimulates the pineal gland.

The pineal gland secretes a hormone called melatonin, which, among other things inhibits the gonads from secreting their hormones testosterone in males, estrogen in females Like the processes that control flowering in plants, the pineal is stimulated to produce melatonin by darkness, not by light Thus it is responsible for sexual game in man also

Moreover, the pineal plays an important role in regulating the onset of puberty, when a lovable child gradually turns into teenage monster Something inside the brain counts the months and the year, patiently waits until the body has reached the proper growth, and then triggers a flood of hormone for the purpose.

The pineal gland influences the activity of the pituitary gland, which has been called the body's master gland. Situated below the end of the

hypothalamous, the pituitary is an endocrine gland that secretes hormones that control the body's growth and developments and many of its metabolic activities It is hypothalamus and pituitary that govern the onset of puberty Some researchers believe that the pineal can be thought of as one of the several alarm clocks within the brain that controls sleeps and wakings, etc

It may also be that the pineal gives another signal to pituitary much later in life. The final signal, the signal that begins the process of physical collapse that ends in death Biologists are uncertain about this, but some of them believe that the body has a built-in time limit that no matter how healthy or active a person may be, there is final limit to number of days the body will remain alive It dies of old age because the pineal informs the pituitary and other parts of the brain that it is time to stop

On the basis of the scientific knowledge, it is rather scary to think that pineal is patiently counting the days of your life. Will biologists one day be able to "reset" this internal clock and extend our life span ... ? Will it be possible eventually to trickle the pituitary into making us more youthful ....?

The pineal gland recognizes not only seasonal variations such as, light and darkness but circadian variations too, which produce rhythms in body's chemistry The circadian rhythms affect our growth, body temperature, the way we sleep, eat, work and live our daily lives.

There is one or more than one clocks inside our brain, to which neurobiologists call endogenous pacemakers. They count time, possibly regulated by the pineal's ability to sense the coming and going of light and darkness in the world outside.

2. In fact there are computed to be thousands of *Nadis*

in human body, but of them only, fourteen, are important They are (1) *Susumna,* in the central channel of spinal cord,(2) *Ida*, the left sympathetic chain, stretching from under the left nostril to below the left kidney in the form of a bent bow, (3) *Pingla*, the corresponding chain on the right, (4) *Kuhu*, the pubic nerve of the several plexus, to the left of the spinal cord, (5) *Gandhari*, to the back of the left sympathetic chain, supposed to stretch from below the corner of the left eye to the left leg, (6) *Hasti-Jihva*, to the front of the left-sympathetic chain stretching from below the corner of the left eye to the left great toe of the foot, (7) *Saraswati*, to the right of *Susumna,* stretching upto the tongue (hypoglossal nerves of the cervical plexus), (8) *Pusa*, to the back of the sympathetic chain, stretching from the corner of the right eye to the abdomen (a connected chain of cervical and lumber nerves), (9) *Payasvini*, between *Pusa* and *Saraswati*, auricular branch of the cervical plexus on the left, (10) *Sankhini*, between *Gandhari* and *Saraswati*, auricular branch of the cervical plexus on the left; (11) *Yasasvini*, to the front of the right sympathetic chain, stretching from the right thumb to the left leg (the radial nerve of the brachial plexus continued on to certain branches of the great sciatic); (12) *Varuna*, the nerves of the sacral plexus, between *Kuhu* and *Yasasvini* ramifying over the lower trunk and limbs, (13) *Visvodara*, the nerves of the lumber plexus, between *Kuhu* and *Hasti-Jihva* ramifying over the lower trunk and limbs; (14) *Alambusa*, the coccygeal nerves, proceeding from the sacral vertibrae to the urino-genitory organs (Dr Brojendranath Seal's accounts edited by Sir John Woodroffe, *The Serpent Power*).

3. *Mula* (Root), *adhara* (support) is the root of *Susumna*, which is also the resting place of the *Kundalini*. It is also as it is at the root of all

the six *Cakras.*

All the lotuses have their faces turned downwards, they turn upwards only when the *Kundalini Sakti*, moving up, strikes them

4. *Mantra* : The *Mantra* is a syllable or syllables with power in the form of sound

5. *Vaikhari Sabda* is uttered speech developed in the throat issuing from the mouth

PART - II

KUMBHA MELA : ASTRONOMY AND COSMOBIOLOGY

March 21, it again rises above the horizon when directly east By June 21, the Sun is once more in its most northernly rising place.

The Sun has a cycle, too, in the matter of its height above the horizon. At noon of about Dec 21, it is lowest above the horizon, at mid-day on about June 21 it is highest above the horizon Throughout the year, it fluctuates between the two levels of height above the horizon at noon

The Moon and some planets are bright enough to be seen during the day, but the stars are too dim to be seen then, although sightings from a deep well by an acute observer may reveal some stars in the day sky

Night Sky

The night sky presents the sight of twinkling stars scattered in a definite pattern known as a constellation. The constellations are areas of the sky set off by arbitrary boundary lines to include prominent and easily identified groupings of stars.

Constellations are useful in describing approximate positions of celestial objects. The stars in any particular constellation are, in most cases, not physically associated; they are at greatly varying distances from Earth, and the patterns depend simply upon the observer's line of sight. Many constellations, particularly those of the zodiac, and the north polar region, originated with the ancients, who gave to these patterns names of heroes, animals, and other objects associated with mythology. Others, the "modern" constellations, were given the names of scientific instruments Modern star maps show the new boundaries for 88 constellations In these, some small and insignificant groups are omitted, and some very large ones, for example, Argo Navis in the southern sky, are broken up into smaller groups.

The following list contains the constellations now used (*Encyclopaedia Britannica, 1967*).

Northern

Andromeda	Cygnus	Ophiuchus
Aquila	Delphinus	Pegasus
Auriga	Draco	Perseus
Bootes	Equileus	Sagitta
Camelopardalis	Hercules	Serpens
Canes Venatici	Lacerta	Triangulum
Cassiopeia	Leo Minor	Ursha Major
Cepheus	Lynx	Ursha Minor
Coma Berenices	Lyra	Vulpecula
Corona Borealis		

Central (Zodiacal)

Aquarius	Gemini	Sagittarius
Aries	Leo	Scorpio
Cancer	Libra	Taurus
Capricornus	Pisces	Virgo

Southern

Antlia	Dorado	Orion
Apus	Eridanus	Pavo
Ara	Fornax	Phoenix
Caelum	Grus	Pictor
Canis Major	Horologium	Pisces Austrinus
Canis Minor	Hydra	Puppis
Carnia	Hydrus	Pyxis
Centaurus	Indus	Reticulum
Cetus	Lepus	Sculptor
Chamacleon	Lupus	Scutum
Circinus	Mensa	Sextans
Columba	Microscopium	Telescopium
Corona Austrina	Monoceros	Triangulum Australe
Corvus	Musca	Tucana
Crater	Norma	Vela
Crux	Octans	Volans

Each of the 88 constellations consists of many astronomical objects besides stars, at varying distan-

ces Although at any one moment, everything within a constellation appears to be fixed and equidistant, yet one may have a meteor within our own Earth's atmosphere, a planet relatively close to us, a star many thousand times distant, and a system of billions of stars many million times farther away, all in the same constellation

If the night sky be observed regularly for a year, different constellations will be seen rising in the east During any one year, the twelve zodiacal constellations rise in the region where the Sun rises Every month a different constellation rises with the Sun Every year the cycle is the same The position of the different constellations in time and space can be located in Figs. 10 & 11)

Brighter and more disc-like in appearance than stars, the planets move in the same section of the sky where the Sun travels. Planets move steadily eastward from night to night, but regularly reverse their direction and travel westward for several nights or months in succession The Sun, Moon and stars move steadily westward Practically all the astronomical objects in the sky *partake* of daily diurnal motion, forming concentric circles or parts of circles about Polaris, the North Pole star All astronomical objects are parts of one of the 88 sections of the sky called constellations Meteors, of shooting stars, *nebulae*, or gases between stars, and galaxies, or systems of billions of stars are as much within constellations as are Sun, Moon, planets, comets and stars

In the northern skies, are seven stars called 'Big Dipper', which form the well-known guide to the north star, Polaris. The stars are about equally distant from one another, and Polaris is five such spaces distant from one of the two so-called pointer stars The Polaris maintains a relatively fixed position throughout the night, while other stars move in a concentric circular paths about it.

CONSTELLATION



Fig. 10. (After *Encyclopaedia Britannica*)



Fig. 11. (After *Encyclopaedia Britannica*)

Zodiac

Some well known constellations are ones through which the solar system apparently travels - the zodiacal constellations It is a common practice with makers of almanacs to indicate the positions of the planets by the sign of zodiac in which they are to be found

It is an imaginary belt or zone of sky, or celestial sphere, 18^{o} wide and centred on an ecliptic (the path of the Sun) within which th Sun, Moon and the planets move The stars in the zodiac are grouped into constellations, most of which have figures of animals, hence the name zodiac, or animal circle

The zodiac is divided into 12 sections, called signs, in each of which Sun is situated for one month of the year Each sign, 30^{o} in length, is named from a constellation with which the sign originally coincided. These twelve zodiac constellations, beginning from the vernal equinox, the first point of Aries, in order westward, are described below

Aries

The ram, in astronomy, a zodiacal and autumnal constellation Among the twelve zodiacal constellations, Aries was considered as the first, because about 2,000 years ago when the zodiacal constellation were arranged, the Sun was in Aries where it crossed the equator at vernal equinox. Because of precession of equinox, now this reference point has moved into the constellation Pisces However, Aries remains the first sign of zodiac.

Taurus

The bull, in astronomy, a winter constellation It is the second sign of the zodiac. The group consists of two notable star clusters, the Hyades and the Pluades The Hyades is a V-shaped cluster, the V forming the head of the charging bull, with a fiery bright star Aldebaran in the right edge. This star has long been used in navigation Farther west lies the compact, beautiful

cluster of six stars, the famous Pluades

Gemini

The twins, in astronomy, is winter zodiacal constellation Gemini is the third sign of the zodiac It contains first - second -, and third - magnitude stars These stars - **alpha, beta, gamma and meu,** form a rough quadrilateral figure This constellation is viewed as the figures of the twin heroes Castor and Pollux, with the two brightest stars of the same names symbolizing heroes heads Pollux, slightly brighter than castor, is a navigational star The Sun is in this constellation at the time of summer solstice

Cancer

The crab, in astronomy, a winter constellation and the faintest of the zodiacal groups. Cancer, the fourth sign of zodiac, is important because during early times it marked the northern most limit of the ecliptic, when the zodiacal system was adopted The tropic of Cancer takes its name from this constellation Four faint stars form a rough Y outline, which is suggestive of a crab. In the centre of Cancer is a hazy object It is a magnificent cluster of faint stars, called Praesepe or the Manger.

Leo

The lion, in astronomy, is a magnificent zodiacal constellation appearing during spring and early summer It is the fifth sign of the zodiac. Leo is well defined and bears a close resemblance to the creature it denotes Associated with which can be seen radiating from Leo in November of each year and appearing especially brilliant at intervals of about 33 years.

Virgo

In astronomy, a constellation handed down from antiquity, visible throughout the summer month. The sixth sign of the zodiac represents a maiden. The

brightest star in this constellation, Spica is a spectroscopic binary with a massive dark companion It is a fine first magnitude star of the purest white tint It is also a navigational star

Libra

The balance, in astronomy, appearing during the spring. It is the seventh sign of the zodiac The constellation consists of faint star and is not conspicuous It lies just west of the claws of Scorpius The main stars, α, β, γ and σ, the outline of a four sided figure resembling a balance with beam and pans

Scorpio

The Scorpio, in astronomy, one of the most fascinating and vivid constellations in the sky Scorpio is the eighth sign of the zodiac The bright red star Antares is situated at the heart Antares is one of the largest stars known, containing a diameter of approximately 450 times that the Sun. As in Sagittarius, the Milky-Way in Scorpius is bright and rich in star clouds and clusters

Sagittarius

The Archer, in astronomy, a zodiacal and summer constellation, the major portion of which lies directly on the Milky-Way Sagittarius is the night sign and the southernmost constellation of the zodiac The Milky-Way in Sagittarius is very bright, containing rich star fields and clusters, because its direction lies in the centre of Milky-Way steller system

Capricornus

The sea goat, in astronomy, an inconspicuous zodiacal constellation in the southern sky lying between Aquarius and Sagittarius, Capricornus is the tenth sign of the zodiac. The constellation has been described from the earliest times as a goat, or as a figure that is part goat with the tail of a fish. The tropic of Capricorn

originates from this constellation, which marked the southern limit of ecliptic in the past

Aquarius

The water bearer, in astronomy, a large zodiacal constellation visible in both summer and autumn Aquarius is eleventh sign of zodiac To ancients, the constellation resembled a man pouring a stream of water from a jar, four stars, η, ∂, π and γ arranged like Y, form the head of the water bearer The stream of water flows into the fish's mouth in the constellation Pisces Austrinus (southern fish) Fomalhaut, bright and solitary in this part of the sky, is one of the relatively important navigational stars From earliest time this constellation has been associated with water, probably because of Sun is seen in Aquarius during the rainy season of February

Pisces

The fishes, in astronomy, a zodiacal constellation appearing in the autumn evening sky Pisces is the twelfth and last sign of the zodiac. It is inconspicuous, containing no star brighter than the forth magnitude. However, it is an important constellation because the vernal equinox, which marks the beginning of the astronomical years, is now located in it.

When the zodiacal constellations first came into vogue some 2000 years ago, the vernal equinox was at Aries. Because of the precession of the equinoxes, each of zodiacal sign has since moved westward 30° along the ecliptic. Thus all signs are now displaced into the neighbouring constellations For example, the sign Aries is now in the constellation Pisces.

Celestial Sphere

It is an imaginary sphere on which all celestial bodies appear to be projected; its centre is the observer, to

whom its radius is infinite Except for effects of refraction and visible horizon features, the "dome" of sky seen by the observer at any one time represents half of the sphere On any clear night, the dome appears dotted with stars, and on many nights planets and the Moon can be seen From one year to the next the stars appear to maintain the same positions relative to one another, their distances from the Earth are so great and their actual angular motions so small that for many purposes they can be considered "fixed" However, the aspect of the sphere changes throughout the night and day, and throughout the year The eastward rotation of the Earth causes an apparent diurnal westward motion of the sphere: the Sun and Moon rise and set, the pattern of the stars moves across th sky Due to annual revolution of Earth around the Sun, stars that are visible on the sphere on a winter night are masked by Sunlight on a summer day Projected against these motions of stars are those of the Moon, the planets, comets, and meteors

The diurnal motion of the celestial sphere appears different from different vantage points on Earth At North Pole, the entire sky seems to rotate slowly about a vertical axis passing through the zenith, counterclockwise once a day. At the South Pole, the apparent motion of the sphere takes place in the same manner, but clock-wise. At Earth's equator, the celestial sphere appears to turn about an axis that passes through the north and the south points; so that all celestial bodies rise vertically from the eastern horizon and set vertically to the western horizon.

At any latitude other than the poles or the equator, the celestial bodies follow diurnal paths that are oblique to the horizon. One or the other of the celestial poles will be above the horizon by a distance equal to the latitude of the position. Celestial bodies close to the pole, at least as close in angular measure as the latitude of the observer, will not rise or set, but will turn slowly around the pole. Such bodies are

called *circumpolar* In other parts of the sky at any of the mid-latitudes the celestial bodies rise and set at an angle to the horizon which is equal to the co-latitude of the observer The diurnal paths of all bodies are along circles parallel to the celestial equator

Distances to the stars are so great that the revolution of Earth around the Sun produces no perceptible change to the unaided eye as regards their positions relative to one another on the celestial sphere Certain factors, e g precession and proper motions of the stars themselves, cause the stars to shift on the sphere very slightly, but it requires hundreds and even thousands of years for these slight shifts to become noticeable to the unaided eye The Sun, Moon and the planets, however, are much closer to Earth, and undergo periodic and easily observed changes in their positions on the sphere

The annual revolution of the Earth causes the direction of our line of slight to the Sun to shift eastward, the direction of Earth's revolution, by about 1^{o} *per day, or completely around the sphere in one year* The westward diurnal motion of the Sun, therefore, takes place at a slightly slower rate than that of the stars

The effect of revolution on the Moon is even more apparent Since the Moon revolves around Earth once in about twentyseven and one third days, it appears to shift eastward, the direction of its motion, completely around the sphere in this period. This amounts to a shift of about 13^{o} per day. The rate of Moon's eastward diurnal motion, therefore, is considerably less than that of the stars it requires on the average nearly 24 hours and 50 minutes to move around the sky. If the Moon is observed close to a certain bright star, it will be seen to move eastward with respect to that star by one diameter per hour, and can often be seen to cover and uncover a star within an hour.

There is a similar shift in the position of planets

because of their revolution around the Sun as well as the Earth's revolution Each planet constantly shifts its position on the celestial sphere The closer it is to the Sun, the more rapid is its revolution, and hence the greater its apparent movement The shift of the planets on the sphere is generally eastward, except for certain periods when the revolution of the Earth produces an apparent relative motion in a retrograde, or westward, direction

Milky-Way

Within the celestial sphere, there is the Milky-Way - our galaxy It is the faintly shining band of stars that stretches more or less in a great circle around the sky. It can be seen on any clear night, and is best viewed against inky-black tropical night skies. The band of Milky-Way is composed mainly of multitudes of faint stars It outlines the central plane of the Milky-Way system, often also called our galaxy - the star system of which our Sun is a part. The phenomenon of the band of the Milky-Way is produced by stars at greatly varying distances, some of them within a few hundred light-years of the Sun, others possibly as distant as 20,000 light-years or more.

Our Milky-Way system contains approximately 100 billion stars, some of them intrinsically much brighter than our Sun, others intrinsically very much fainter, and with our Sun near the middle of the scale of intrinsic brightness. The Milky-Way system is a *flattened* spiral galaxy with a circular diameter of approximately 100,000 light-years, and a maximum thickness, in central region, of the order of 1000 light-years. The whole Milky-Way system is probably embedded in a vast, almost spherical *hole* of very thinly distributed interstellar gas and relatively inconspicuous stars of great cosmic age.

Our Sun is a star close to the central plane of the galaxy,but at a distance of 25,000 to 30,000 light-years from the centre of the system. The high flattening

observed for our galaxy suggests that the whole system must be in rapid rotation, and this has indeed been confirmed by direct observation The solar system and most of the stars in its vicinity move around the galactic centre at approximately 150mi/sec, requiring close to 200 million years to complete one single circuit around the galactic centre The eccentric location of the Sun is confirmed in a variety of ways In Sagittarius and Scorpius the Milky-Way is both brighter and broader than in other parts, in the opposite direction in the sky, near Auriga and Gemini, are the thinnest and the least spectacular regions The distant globular star clusters exhibit a striking concentration towards the Sagittarius-Scorpius section of the Milky-Way

The most interesting feature of our Milky-Way system is that it apparently exhibits a spiral structure in and near the central plane In this respect our galaxy resembles the spiral galaxies beyond it, which are found in great numbers. There are two basic star populations in the Milky-Way system. Population I, which is found mostly in the outlying regions, is composed of interstellar gas and cosmic dust and blue white supergiants, singly or in groups, that are associated with the spiral structure The stars of population I are young on cosmic scale of time measurement - 10 to 100 million year old, which is about 1/100 of the age of Sun and Earth Population II contains the vast numbers of less spectacular older stars, none of them intrinsically very brilliant, which inhabit the spaces between the spiral arms and central core of our galaxy as well as the thinly populated outer hollow The population II stars are the oldest stars, with estimated ages equal to at least 10 billion years, twice the age of Sun and Earth Population II includes a great variety of objects of varying ages, some of them probably twice as old as Earth, and built from the cloud of, presumably, almost pure hydrogen from which our Milky-Way system came. The Milky-Way system is under going continuous slow evolution

Other Galaxies and the Universe

In the early part of this century, large telescopes in America showed many other galaxies, besides our own Milky-Way Galaxies come in many different shapes and sizes, and more than half of all galaxies are grouped into clusters, with the rest scattered in the spaces between the clusters Distances between galaxies in a cluster are vast (about 10 times the size of galaxy), but even these distances are small compared with distances between clusters

Then universe can be seen as a collection of large number of galaxies, and each galaxy will consist of a still larger number of stars. Observation have also shown that the other galaxies and clusters are all rushing away from us at vast speeds, part of the general expansion of the universe This expansion is the result of the Big Bang explosion that gave birth to the universe

Solar System

The Sun and the bodies moving about it form the solar system There are more than 10^8 stars in the galaxy, but only in the case of the solar system a star with an accompanying planetary system is known The other stars are all so far away that there has been no means of detecting possible accompanying planets. The Sun is about $3x10^7$ light years ($3x10^{20}$ km) from the centre of the galaxy, a part of the flattened distribution of stars forming the disc of the galaxy The galaxy also has a substantial spheroidal content of stars, which are believed to have been the first to form when the galaxy came into being.

The planetary system contains an inner group of four planets, Mercury, Venus, Earth and Mars, which are primarily composed of rocks and iron. A large number of very small bodies, typically only a few kms in radius or less, called asteroids, occur in orbits beyond that of Mars. These are primarily rocky in composition.

Beyond the asteroids lies the largest planet in the solar system, Jupiter. Jupiter is mainly composed of the light gases, hydrogen and helium Saturn the second most massive planet in the solar system, lying beyond Jupiter, is basically similar in composition and structure to Jupiter Beyond the Saturn lie two intermediate-mass planets, Uranus and Neptune While these planets contain substantial amounts of hydrogen and helium, the bulk of their mass appears to be composed of heavier elements - probably some combination of rock materials plus "ices" water ammonia and methane

Still farther out is a very small planet, Pluto, considerably less massive than the Earth, and apparently composed mainly of rocks and frozen ices

Well beyond the region of the planets lies a huge region of space, out to about 1,00,000 astronomical units (1 5x10^{3}km) from the Sun, which appears to contain a very large number of small frozen bodies, called comets. The space within the solar system is filled with much smaller bodies. These are the meteorites, which become bright meteors or "fireballs" after entering the Earth's environments.

From the nearest to the farthest away from the Sun, the planets, in order, are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune and Pluto We know that the Sun is a star, and we consider the Moon as a satellite of Earth, which is itself a true planet. The modern astrophysical concept of a planet is that it shines only by reflected Sunlight and that it is much colder than the Sun Planets differ basically from comets in being very much denser, and in lacking gaseous cosmos or tails, and from meteorites in being large enough to be observed outside the Earth's atmosphere. The various physical parameters of the planets of the solar system are given in table 3 and they are mentioned in the following pages.

Table 3

The Planets : Orbital Information and Physical Characteristics

(1) Mean distance from Sun (Millions of km)	Mercury	Venus	Earth	Mars	Jupiter	Saturn	Uranus	Neptune	Pluto
	57.9	108 2	149 6	227 9	778 3	1427	2869	4496	5900
(2) Period of revolution(days)	88 days	224.7 days	365.26 days	687 days	11 86 year	29 46 year	84 01 year	164 1 year	247.7 year
(3) Rotation period	59 days	-243 days retro-grade	23hr 56min 4sec	24hr 37min 23sec	9hr 55min 30sec	10hr 39min 20sec	17 24hr	22hr or less	-6days 9hr 18 min retro-grade
(4) Inclination of axis	2°	3°	$23^{\circ}27'$	$25^{\circ}12'$	$3^{\circ}5'$	$26^{\circ}44'$	$97^{\circ}55'$	$28^{\circ}48'$	60°?
(5) Inclination of orbit to ecliptic	7°	3.4°	0°	$1\ 9^{\circ}$	$1\ 3^{\circ}$	$2\ 5^{\circ}$	$0\ 8^{\circ}$	$1\ 8^{\circ}$	$17\ 2^{\circ}$
(6) Eccentricity of orbit	0.206	0.007	0 017	0 093	0 048	0 056	0 047	0 009	0.25
(7) Equatorial diameter (km)	4880	12104	12756	6787	142800	120400	51800	49500	3500

(8) Atmosphere (principal components)	Virtually none	Carbon dioxide	Nitrogen, Oxygen	Carbon dioxide	Hydrogen, Helium, Methane	Hydrogen, Helium, Methane	Hydrogen, Helium, Methane	Hydrogen, Helium, Methane	Methane
(9) Known Satellites	0	0	1	2	16	21	15	2	1
(10) Rings	-	-	-	-	Yes	Yes	Yes	-	-
(11) Apparent visual mag	-1.9	-4 4	-	-2 8	-2 5	0 04	+5 6	+7 9	+14 9
(12) Mass (Earth=1)	0 056	0 82	1 0	0 11	318 35	95 2	14 6	17 6	?
(13) Velocity escape(mi/sec)	2.6	6 4	7 0	3.2	37 1	22 0	13 9	15 5	?
(14) Oblateness	0 0	0 0	0 0034	0 0052	0 062	0 096	0 06	0 02	?
(15) Surface Gravity(Earth=1)	0.37	0 89	1 00	0 39	2 54	1 06	1 09	1 41	?
(16) Mean density (Water=1)	5.2	5 1	5 52	4 1	1 34	0 68	1 75	2 2	?

(After Meyers (ed), 1987)

Sun

It is a star around which the Earth revolves, and is the latter's sources of light and heat The Sun is a globe of gas, 1 4x10^6km in diameter, held together by its own gravity Because of the weight of the outer layers, the density and the temperature increase inward, until a central temperature of over 1,50,00,000K and density more than ninety times that of water is reached At these temperatures and densities, thermonuclear react-ions converting hydrogen into helium take place, releasing the energy that streams outward

The surface temperature of the Sun is about 10,000°F (6,000K) Since solids and liquids do not exist at these temperatures, the Sun is entirely gaseous Though all the gases are in atomic form, a few molecules exist in the coolest regions at the surface

The Sun is a typical member of a class of numerous stars, the spectral type dG2 (d indicates dwarf)

Solar Structure

A central density of about 90g/cm^3 has been found, decreasing to 10^{-7}g/cm^3 at the surface. Studies have further shown the central temperature of about 1,50,00,000K, decreasing to 5,000K at the surface Since this takes place over 7,00,000 km, the temperature gradient is only 25K per kilometer The radiation produced at the centre by the nuclear interactions flows outward rapidly

The energy of the Sun is produced by the conversion of hydrogen into helium In the course of reactions, electrons, protons and neutrons are produced In the outer regions of the solar interior, the temperature is low enough for ions and even neutral atoms to form and, as a result, atomic absorption becomes very significant The high opacity makes it very difficult for the radiation to continue outward; steep temperature gradients are established, which results in convective

currents. Most of the outer envelope of the Sun is in such a convective equilibrium These large-scale mass motions produce many interesting phenomena at the surface, including sunspots and solar activity

Radiation

Electromagnetic energy produced by the Sun contains essentially all the wavelengths. However, more than 95% of the energy is concentrated in the relatively narrow band between 290 and 2,500 nanometers and is accessible to routine observation from ground stations on Earth The maximum radiation is in the green region, and the eyes of human beings have naturally evolved to become sensitive to this range of the spectrum The sum total of the radiation received from the Sun is termed the solar constant.

Atmosphere

Although the Sun is gaseous, it is seen as a discrete surface from which practically all the heat and light are radiated. One observes through the gas to the point at which the density is so high that the material becomes opaque. This layer, the visible surface of the Sun, is termed the photosphere Light from further down reaches the Earth by repeated absorption and emission by atoms, but the deepest layers cannot be seen directly

Looking at the Sun in isolated wavelengths absorbed by its atmospheric gases, one can no longer see down to the photosphere, but instead one sees the higher levels of the atmosphere, called chromosphere. The chromosphere is a rapidly oscillating region of jets and waves coming up from the surface. When the entire convected energy emerging from below reaches the surface, it is concentrated in the thin material and produces considerable activity. Consequently, this outer region is considerably hotter than the photosphere, with temperatures up to 30,000K.

The corona can be seen on the occasion of total

solar eclipse. It is a vast extended atmosphere of the Sun. The corona is transparent and is visible only when seen against the dark sky of an eclipse Its density is low but its temperature is high. The hot gas evaporating out from the corona flows steadily to the Earth and beyond in what is called the solar wind

Most of the time the corona is weak over the poles X-ray pictures revealed great bands of the solar surface essentially devoid of corona for many months These proved to be regions where the local magnetic fields were related to quite distant places, so the fields actually reached out to heights from which the solar winds could sweep the gas outward. Analysis of solar wind data showed that equatorial coronal holes were associated with high velocity streams in the solar wind, and recurrent geomagnetic storms were associated with the return of these holes. Thus, the great intensity of the corona over sunspot regions is partly due to their strong, closed magnetic fields which trap the coronal gas.

Solar Activity

The transient phenomenon, known collectively as solar activity, are all connected with sunspots or their remnants and wax and wane in a remarkable cycle of activity. The sunspot cycle consists of variations in the sizes, numbers, and locations of sunspots, expressed quantitatively as the sunspot number. The number of sunspots peaks soon after the beginning of each cycle and decays to a minimum in eleven years. The magnetic polarity of the sunspot groups reverses in each successive cycle so that the complete cycle lasts 22 years. The first spots of a cycle always occur at higher latitudes, between 20° and 35°, and as the spots increase in size they occur closer to the equator. Outside the latitude range of 5°–35°, no spots are observed. The average duration of the cycle from the first appearance of the last low latitude spots is nearly 14 years The difference between these two

figures is the consequence of overlap of consecutive cycles

Sunspots

These are the most conspicuous features of solar activity and can be easily seen through a small telescope They are the dark areas of the Sun produced by the most intense magnetic fields The magnetic fields cause a cooling of the surface, most likely by suppression of the normal convection with transport energy from the lower levels Devoid of the supply of heat, the area cools by radiation and becomes a dark sunspot. Curiously enough, the region close to the cool sunspot is the scene of the hottest and the most intense activity because of the great magnetic energy present in the sunspot

Prominences

Although prominences appear dark against the disk, they appear bright against the dark sky. They occur only in the regions of horizontal magnetic fields, because these fields support them against the solar activity. These are among the most spectacular of the solar phenomena

Plages

Just as prominences occur when the magnetic field alters from one sign to the other, plages occur whenever the magnetic field is vertical and relatively strong They are bright regions. It is now held that the field is, in fact, stable only when it exceeds 1000 gauss (0 1 tesla), and the difference between apparently weaker field regions, such as, chromosphere networks, and plages is only the density of clumps of strong field. Plages are normally associated with sunspots, a typical active region will have the preceding magnetic field clumped in a sunspot and the following field spread out in a plage

Flares

The most interesting activity associated with sunspots is the solar flare A flare is characterized by an abrupt increase in the H-(alpha) emission from the sunspot region The brightness of the flare may be five times that of the associated plage; the rising time is seldom longer than a few minutes. Observations show that there is a tremendous energy release, as much as 10^{33} ergs (10^{26}J) in a fare.

The solar flares occur only as a result of sunspot activity Practically all sunspots produce flares, but certain spots are prodigiously active The source of the flare energy is the magnetic field surrounding the sunspots.

MARS - GOD OF WAR

Mars, the planet fourth in distance from the Sun It is visible to the naked eye as a bright red star, except for short periods near its conjunction with the Sun. Having a mean (synodic) period between oppositions of 780 days, Mars is in opposition with the Sun every other year.

Mars usually appears as a bright reddish disk marked by complex, semipermanent dark regions and variable polar caps. Scientists have long known about atmospheric phenomena, variable polar caps of ice and clouds, and large bright and dark regions on the surface with dimensions of several hundred kilometers or more. But a multitude of other small surface formations with characteristic scales less than 125 mi (200 km) manifest their existence by the optical illusion of "canals" and "oases".

Surface

The Martian surface that initially resembled the heavily cratered lunar uplands, has been modified extensively by the process of volcanism, faulting, and the effects of wind and water. The northern hemisphere tends to be

characterized by large volcanic lava plains, whereas the southern hemisphere appears to be older and more heavily cratered.

Of the most impressive features on the Martian surface are several enormous sheild volcanoes, larger than any mountain on Earth. The largest and perhaps the youngest is the Olympus Mons, which is approximately 600km. across at its base and stands approximately 26km above the surrounding terrain. Besides, there are other sheild volcanoes viz , Ascraeus Mons, Pavonis Mons, and Arsia Mons

The most spectacular features on the Martian surface are the huge canyons located primarily in the equatorial region. In places, the canyon complex is as much as 500km. wide and drops to more than 6km. below the surrounding surface. An interesting class of features on the Martian surface is a widespread network of channels that bear a very great resemblance to dry river beds. Ranging from broad, sinuous features nearly 60km wide, to small, narrow networks less than 100m wide, the channels present the strong impression that they were created by water erosion. The seasonal cycle of growth and decay of the bright polar caps has long bee. taken as evidence of the presence of water on Mars. However, evidence from the Mariner spacecraft identified carbon dioxide as the principal constituent of the polar snow, with lesser amounts of water ice also present.

Atmosphere

The Martian atmosphere is very thin. It is composed mainly of carbon dioxide, but contains nitrogen organ, oxygen, and a trace of water vapour totalling about 5%. Both carbon dioxide and ice form clouds in the Martian atmosphere.

Localized dust storms appear very often on Mars. Because of extreme thinness of the Martian atmosphere, wind velocities greater than 40-50/S are needed to set surface dust grains in motion, although they can then be

carried to high altitudes by winds of lesser velocities Some dust storms develop with such intensity that their total extent may be hemispheric or even global

In biological investigations, attempts were made to settle the question of whether life existed on this planet. One of the biological experiments gave a positive result - the release of oxygen from a soil sample when humified - but there is no consensus among the researchers as to the source of this reaction

Satellite

Mars has two small satellites - Phobos and Deimos. Neither satellite is massive enough to have gravitationally contracted to a spherical shape Both satellites have the same low albedo, approximately 0 05 unit. This low reflectivity suggests that the Martian satellites may have had their origin in the asteroid belt.

VENUS - GODDESS OF LOVE AND BEAUTY

It is the planet second in distance from the Sun This neighbour of the Earth is very similar to it in such gross characteristics as mass, radius, and density. In other ways, it is conspicuously different. The atmospheric mass of the Venus is almost a hundred times that of the Earth; its atmosphere is mostly carbon dioxide instead of nitrogen and oxygen; an extensive cloud layer of concentrated sulfuric acid is present; its surface temperature is 730K (850^{o}F), and it rotates with a period of 243 days, from east to west, in the opposite direction of most other planets Many of these differences are due to differing evolutionary paths of the two planets rather than to totally different initial conditions

To the naked eye, Venus is the brightest starlike object in the sky. This is normally visible during the night, either soon after Sunset or close to the Sunrise. More rarely, it can also be seen during the daytime.

The light coming from the Venus is almost entirely due to Sunlight that is reflected from a dense cloud layer. The clouds of Venus consist of a large number of tiny particles that are made of a water solution of concentrated sulfuric acid

Studies have shown that the atmosphere of the Venus is consisting of 96% carbon dioxide, while nitrogen accounts for almost all the remainder

The very similarity between mean density of the Venus and the Earth suggests that Venus is made up of rocks rich in silicon, oxygen, iron and magnesium, and a thin outer crust containing rocks enriched in silicon in comparison with the rocks of the mantle However, in contrast to the situation on Earth, Venus's core may now be solid, a fact which could account for the absence of a detectable magnetic field.

The ubiquitous cloud layer totally obscures Venus's surface at visible wavelengths. Observations made with radar telescopes reveal the presence of large, circular features over its surface. These may be giant craters produced by impacting meteoroids. Besides, there are features that resemble large volcanic constructs, enormous rift valleys, and jagged mountain ranges There is little topographic relief over most of the planet's surface. However, in a few places large continental size plateaus rise about 10km above the surrounding plains, while in other places isolated low lands occur

MERCURY - MESSENGER OF THE GODS

This planet is nearest to the Sun. It is visible to the naked eye shortly after Sunset or shortly before Sunrise when it is near its greatest angular distnace from the Sun. Its mass is 0 055 times the mass of the Earth Mercury has the highest density of all planets except the Earth, indicating that iron and nickel may be its main chemical constituents. The surface of the planet is composed of silicate rock, heavily cratered from

exposure to impacting meteorite debris There is no atmosphere

On this planet, maximum surface temperature varies with distnace from the Sun, at perinelion reaching 800°F at the equator At night, however, the unsheilded surface cools rapidly to below -340°F, producing the greatest diurnal variations in temperature in the solar system The face of the Mercury shows evidence of internal geologic processes as well as the scars of impacts. Much of the surface appears to be flooded with lava, in the same manner as the lunar Maria, perhaps as a result of extensive vast volcanism. There are many great compressional scarps that cut across other topographic features and appear to have been caused by the shrinkage of the planet as its interior cooled

JUPITER - THE GIANT OF THE PLANETS

The largest planet in the solar system, and the fifth in the order of distance from the Sun It is visible to the naked eye, except for short periods when in near conjunction with the Sun Usually it is the second brightest planet in the sky only Mars at its maximum luminosity and Venus appear brighter. It is brighter than Sirius, the brightest star On viewing from optical telescope, Jupiter appears as an elliptical disk strongly darkened near the limbs, and crossed by a series of bands parallel to the equator. The details observed, however, do not correspond to the solid body of a planet, but to clouds in its atmosphere, and the rotation period differs markedly with latitude.

Apart from the constantly changing details of the belts, the most conspicuous and permanent feature noted is the great red spot

Atmosphere

The atmospheric pressure is probably little less than 3 atm (300 kilopascals) The atmosphere appears to be largely composed of hydrogen and helium. The radio-

metrically determined temperature of the visible disk of Jupiter is $-225^{o}F+55^{o}F$ Pioneer 10 and 11 fly-bys indicated that Jupiter's zones and belts consist of gases at different altitudes and temperatures. Agents for band colours are, however, yet to be determined

The Voyager probes showed that the Jovian clouds are affected by the same varieties of weather patterns that produce terrestrial weather, though on a much larger scale Measurements of the velocities of surface features show that the Jovian atmosphere consists of regular patterns of alternating east and west wind velocities.

Internal Features

Jupiter is primarily made up of liquid and metallic hydrogen. Its composition is similar to that of the Sun, namely, ten times as much hydrogen as helium. Under the extreme pressures of the interior of the planet, the hydrogen would remain in a liquid metallic state, and this material is supposed to make up the inner 60% of the radius of the planet. It is held that above this layer there lies liquid hydrogen, with the pressure and temperature lowering sufficiently to become gaseous in nature at approximately 1000km. below the cloud tops It appears likely that the core of the Jupiter consists of heavy iron-silicate molten material of several times the Earth's total mass, and has a probable radius of a few thousand kilometers

Jovian Ring

The brightest part of the Jovian ring, as discovered by Voyager-2, is approximately 6000km. in diameter, but the ring itself may probably extend all the way to the planetary surface.

Satellites

The Jupiter has fifteen known satellites of which the four largest (I) Io (II) Europa (III) Garymede and (IV)

Callisto, discovered by Galileo in 1610, are by far the most important These are visible to the naked eye, while others are faint telescopic objects

SATURN - THE RINGED PLANET

The Saturn is the second largest planet in the solar system and the sixth in order of distance to the Sun It is surrounded by a beautiful system of rings Saturn is also the only planet that has a satellite (Titan) with a dense atmosphere

Saturn makes one revolution about the Sun in 29 46 years The equatorial diameter of Saturn is about 120,800km, and the polar diameter about 109,800 km The volume is 769 (Earth=1) with a few percent uncertainty The mass is about 95 2 (Earth = 1) or 1/3500 (Sun = 1) The mean density is 0.68 g/cm^3, the lowest mean density of all planets The rotation axis of both the planet and the associated rings is inclined $26^{\circ}45'$ to the perpendicular to the orbital plane The disk of Saturn is much more homogeneous than that of the Jupiter.

The optical spectrum of the Saturn is characterized by strong absorption bands of methane and by much weaker bands of ammonia Absorption lines also indicate the presence of molecular hydrogen

The temperature of the planet is suggested to be $-323^{\circ}F$ (76K) It indicates that Saturn has an internal heat source of roughly the same magnitude as that on Jupiter. A thermal inversion exists in the upper atmosphere

The theoretical models for the internal structures of the Saturn resemble that for Jupiter, that is, a dense core surrounded by hydrogen compressed to a metallic state which gradually merges into an extremely deep atmosphere

The fact that the two planets radiate comparable amounts of energy despite their differences in size implies that the smaller Saturn must have some addit-

ional energy source besides gravitational contraction The existence of a magnetic field and belts of trapped electrons has been inferred from observations of non-thermal radiation

Jupiter and Saturn are relatively similar bodies Both seem to have a composition virtually identical to that of the Sun and other stars, i e. rich in hydrogen and helium In that sense, they may represent the primitive material from which the entire solar system was formed, whereas the other planets have undergone fractionation process resulting in the loss of most of the light gases

The most interesting feature associated with Saturn is the complex ring system that surrounds the planet The system has been divided into six principal regions, designated A through F It is noted that the ring system consists of myriad separate particles that move independently in flat, most circular orbits in Saturn's equatorial plane. Periodic perturbations by the major satellites are responsible, in part, for the main divisions of Saturn's rings

Saturn has 21 known satellites Of these the largest and brightest is Titan, and others are much fainter Titan's mean apparent diameter corresponds to a linear diameter of nearly 5800km But this diameter refers to the satellite's atmosphere, which is filled with dense aerosol produced photo-chemically by incident Sunlight The solid surface of the Titan has a diameter of approximately 5120km , making this satellite larger than Mercury but smaller than Jupiter's giant Ganymede This object contains a large fraction of icy material and is thus quite different from the Moon or the inner planets in composition. Moreover, it is large and cold enough to retain an atmosphere of gases with relatively high molecular weights The main constituents of this atmosphere is molecular hydrogen The surface temperature of Titan, 93K, can liquify methane Therefore, this substance may play the same role on Titan as water does on Earth

NEPTUNE

The outermost of the four giant planets, a near twin of Uranus in size, mass and composition, Neptune appears as a tiny greenish disk Its linear diameter of 49400km is very similar to that of Uranus The mass of Neptune is 17 21 times the mass of Earth, corresponding to a mean density of 1 66, somewhat above that of its sister planet It indicates that the enrichment of heavey elements is somewhat greater in Neptune than in Uranus, but both must still be composed principally of hydrogen and helium.

Its temperature has been calculated to be -380<198>F (45K) But temperatures measured near a wavelength of 13 micrometers are very much higher, over -280^{o}F (100K) At radio frequencies, its temperature has been found increasing with depth

Neptune has two known satellites The larger and brighter one is Triton Another one is Nereid

PLUTO

Pluto is visible only through fairly large telescopes. Periodic variations in its brightness reveal that the surface of the Pluto is covered with bright and dark markings and indicate a period of rotation of 6 3 days This long period and the high inclination and eccentricity of Pluto's orbit around the Sun have led several scientists to propose that Pluto was originally a satellite of Neptune

Pluto has a small satellite, provisionally named Charan, in a synchronous orbit, i.e., the satellite's period is identical to the rotational period of the planet. The mass of Pluto is almost one-seventh that of the Earth's Moon. It is suggested that with a diameter in the range of 3000-4000 km , Pluto must have a mean density close to $1g/cm^3$ Pluto must be composed largely of ice, a conclusion that gains support from the detection of an infrared absorption band of solid methane in its spectrum The average temperature of

Pluto must be close to 50K (-370^{o}F), which is consistent with the presence of solid methane on the planet's surface, in equilibrium with a small amount of methane gas

URANUS - THE FIRST 'MODERN' PLANET

Uranus is seventh in order of distance from the Sun The obliquity (inclination of rotational axis to orbit plane) of Uranus is the highest of any known planet 97 9^{o} This implies that the axis is almost in the Plane of the orbit, and thus the seasons on Uranus are very unusual During summer in one hemisphere, the pole points almost directly towards the Sun while the other hemisphere is in total darkness 41 years later, the situation is reversed

The linear equatorial diameter is 51800km The mass is 14 63 times the mass of the Earth. The mean density is greater than that of Saturn even though Uranus is smaller than Saturn. This indicates that Uranus is richer than Saturn (or Jupiter) in elements heavier than hydrogen and helium but not nearly so rich in these elements as Earth The same holds good for Neptune

The calculated temperature of Uranus is -360 < 198 > F (55K) This is essentially identical with the value that is obtained by direct measurement There is no evidence for the existence of an internal energy source or for a thermal inversion in the upper atmosphere, as noted for Jupiter, Saturn, Titan and Neptune

Uranus appears as a small, slightly elliptical blue green disk, through the telescope The presence of faint, dusky bands on the disk is also reported, when the equator is oriented toward the Earth, but these sightings are not yet fully established. Spectrographic observations have shown that the atmosphere of the planet contains large amounts of methane and hydrogen.

Uranus has five known satellites that form a remarkably regular system, with low orbital eccentricities and inclinations. A system of rings was discovered in

1977 There are at least nine rings, the largest having a width of only 50 km

Moon

As ablate spheroid with a diameters of 2160 miles, the Moon has a slightly elliptical path about the Earth Our planet and satellite make an exceptional pair astronomically No other planet has so large a Moon so close to it

Surface Feature of Moon

Moon has little or no atmosphere and is a grim, barren waste land with wide holes, or craters, mountain ranges, and broad plains

Craters are depressions on the surface of any body Some craters on the Moon are deeper and wider than those on the Earth The widest is about 150 miles in diameter, the deepest goes down below the surface 18000 feet Most Moon craters are extremely shallow, being more like a saucer than a cup Some of the Moon craters have a peak rising from their centre All of them visible from the Earth have been named The prevalence of Moon craters has prompted much speculation about their origin, but no single theory is accepted because all lack supporting evidence. One popular theory credits the origin of craters to meteor bombardment Another widely-held view would have the craters formed by volcanic action. There are, other suggestions combining the above two ideas, as well as the notion that craters form by cooling much like molten chocolate cools

Mountain ranges on the Moon are named after those on the Earth. The Appennines, the Alps, and the Pyrenees are on our satellite. Cracks and ridges are also found on the surface of the Moon as they are on the Earth. Unlike the Earth, our satellite has systems of bright streaks or rays radiating from some craters.

Viewing the somewhat flat areas on the Moon, the ancients believed them to be bodies of water Influenced

by this notion, they gave the sections such names as sea of anger, lake of death, and sea of conflicts The Latin name, Maria, for these broad plains remains, although it means seas Water does not exist on Moon

The Moon has no surrounding blanket of air If an atmosphere did ever exist on our satellite, it would have escaped quite easily Air would need only about one-fourth to one-fifth of the velocity required to escape from the Earth in order to escape from the Moon

Lunar Magnetism

An unexpected finding of the analysis of related rocks, both crystalline and breccia, was their possession of a state remnant magnetization No dipole magnetic field in excess of 5 gammas (1gamma=10^{-1}Gauss) had been detected by lunar orbiting satellite In contrast, magnetometers landed during the Appollo Missions indicated local magnetic field of up to 300 gammas The Appollo 15 and 16 satellites also had indicated complex magnetic anomalies upto 1 gamma Since magnetization appears wide spread on the lunar surface, it is estimated that a field of from 1,000 to 10,000 gammas was required when the rocks were formed 3 2 to 4 1 x 10^9 years ago

The Earth's escape velocity, a measure of gravitational attraction, is about 11km/sec, the Moon's is a little less than 2 5 km/sec, while a speed of 618 km/sec is necessary to overcome the Sun's gravitational pull Evidence that the Moon has little or no atmosphere is plentiful, all the shadows seen on the surface are black without the gray due to scattering by air, parts near the edges are seen sharply, neither clouds nor storm nor haze can be detected; when the Moon cuts off the light of a star, the break is sharp without the shaded light caused by an atmosphere.

Moon's Motions

The Moon has motions corresponding to those of the Earth Rotation about an imaginary internal axis and

revolution around the Earth are the chief movements of Moon The Moon's axis is tipped away from the perpendicular to the Moon's orbit, precession occurs. Being a member of the solar system, the Moon partakes of the Sun's apparent straight line motion and the Sun's revolution within our galaxy

The Moon's rotation and revolution periods are equal because the same surface of the Moon always faces the Earth The Sun shines upon all of the Moon, but the Earth has a view of about one-half the surface

The Moon moves once around the Earth in about twentyseven and one third days This sidereal period is the time for our satellite to reappear in a position such that a straight line may be drawn connecting the Earth, the Moon and a distant star The revolution time is twentynine and half days when the Sun is the reference star Such a synodic month is no longer than a sidereal one because the Moon must move farther than one circle in order to catch up with the moving Earth. The Earth's motion is insufficient with respect to distant star The Earth's motion must be taken into account with reference to the Sun.

Eclipses, Phases, Tides

The position of the Moon with respect to Earth and Sun is responsible for eclipses, phases and tides The position is a prerequisite for the cause of the phenomena to operate in each case

These eclipses in *Kumbha* mythology have been correlated with *Rahu* and *Ketu*. Scientifically, the lunar eclipse results when the Earth's shadow covers the Moon The Earth's shadow is large enough to cover the entire Moon. A solar eclipse results when the Moon's shadow touches the Earth

Phases

The Moon can be seen as a full, round, bright disc once a month. Throughout the month, the Moon is seen in

different portions from a thin crescent to an almost complete circle The reasons for these monthly recurring views of the Moon lie in the speed of revolution of the Moon and the manner in which it is located with respect to Earth and Sun. Its different views are known as phases

The Moon shines by the reflected light from the Sun, and while orbiting around the Earth, it exhibits a striking phase change The Moon is called new Moon, when it is positioned between the Earth and the Sun, at which time the light of the Sun does not reach the side of the Moon that faces the Earth At full Moon, the side of the Moon facing the Earth is completely flooded with Sunlight This is the position where Moon has half completed a revolution about the Earth The various other phases are caused by this revolution about the Earth, as explained below

When the Moon is opposite to the Sun in the sky, the illuminated hemisphere faces the Earth, so that the Moon appears full Because of its orbital motion about Earth, the Moon appears to move eastward against the stars at a rate greater than that of the Sun As the angular distance of the Moon from the Sun decreases, the illuminated hemisphere no longer faces the Earth, and a crescent of the disc is dark The Moon is then gibbous When the angular distance of the Moon from the Sun is 90^{o}, the Moon appears half illuminated, it is then at third or last quarter As the angular distance still further decreases, only a crescent of disc is illuminated Finally as the Moon passes between Earth and the Sun, the illuminated hemisphere faces away from the Earth, the apparent disc is dark, and the Moon is new If the Moon's orbit were exactly in the plane of the Earth's orbit, the Moon would pass exactly between the Sun and the Earth once every synodic period (the period of cycle of the phases) and a total eclipse of the Sun would occur Actually, because of the tilt of the Moon's orbit, total eclipses occur only on those relatively rare occasions, when the Moon is new and also

in the plane of Earth's orbit After new Moon, the Moon becomes crescent again, the points of crescent always pointing away from the Sun When the angular distances of the Moon from the Sun is again 90°, on the other side of the Sun, the Moon is at First Quarter Finally, the Moon passes through gibbous phases to full Moon again. The synodic period lasts, on the average, about twenty-nine and half days

The Moon rotates slowly about its axis which is tipped about 6.5° from the perpendicular to the plane of its orbit This results in a remarkable circumstance that the period of rotation matches the Moon's sidereal period of revolution and is in the same direction Consequently the Moon always turns the same face towards the Earth The sidereal month is defined as the time required by the Moon to complete one revolution around the Earth with reference to the stars, and is 27 days, 7 hours, 43 minutes, 11 5 seconds The interval between one new Moon and the next new Moon or one full Moon and the next full Moon is called synodic month and is 29 days, 12 hours, 44 minutes, 2 8 second long

Every 24 hours, the Moon is about $12\ 2^{\circ}$ farther east in our sky (The Moon's path about the Earth is elliptical, not circular, so that $12\ 2^{\circ}$ is not a precise figure) Degrees can be translated into time units Since the Earth rotates 360° in 24 hours, or 15° every hour, 12.2° is equivalent to 50 minutes. If the successive views of the Moon are 24 hours apart, the Moon will be 12.2° farther east on the sky, or about 50 minutes late in reaching an identical position The time will vary little from day to day and place to place because of varying angles of observing the Moon's apparent rise

As the Sun sets, the full Moon rises, as the Sun rises, the full Moon sets The night after the full Moon, our satellite rises in the east about 50 minutes after Sunset, The disc is almost full. Two evenings after full Moon, the Moon rises 2x50 minutes, or one hour and 40 minutes, later than when the full Moon rose.

The waning disc is now less complete About seven evenings after full Moon, our satellite is one quarter of its way around the Earth One-half circle of the Moon is visible and it rises about midnight, assuming full Moon rose at about 6 p m Each night, until about 15 days after full Moon, the waning Moon appears in a smaller phase and against a different background of stars The terminator, the line between the bright and unseen sections of the Moon, becomes more curved At no time can other astronomical objects be seen where the Moon should be, nor are the horns the cusp of the satellite, directed toward the Sun

New Moon rises and sets with the Sun If the observers on Earth ever get a glimpse of it, light from the Earth reflected from the new Moon back to the Earth is the cause, and not Moon shine After new Moon, the amount of Moon visible to the Earth begins to grow again Seven days after new Moon, a waxing half- Moon rises at noon and sets at midnight During the days following half Moon, waxing Moon rises later each after-noon until full Moon occurs again The term half Moon refers to the portion of the Moon circle seen The term first quarter indicates the Moon's period of revolution

Phases of the Moon

Type of Moon	Approx Rising Time
Full	Sunset
Waning	Sunrise
Waxing Half	Noon

Sun

Representation of phases of Moon

Waning Half Moon

New Moon Earth Full Moon

Waxing Half Moon

It is to be pointed out that because of the inclination of the Moon's orbit, there is seasonal

variation in the path in the sky followed by the Moon During winter-time in the northern hemisphere, the Moon will be higher in the sky than during the summer time

Intensity of Moon-light

The intensity of Moon light is quite weak even though the light of the full Moon makes it possible for a person to move about on foot The light from full Moon has an intensity of about 1/4,65,000th of the Sunlight on a clear day It has been estimated that were the entire sky packed with full Moon, limb to limb, they would give only about 1/6th of the light of Sun The intensity falls off rapidly from the full Moon, either in the earlier or later phases, bearing a non-linear relationship with the area of the Moon illuminated Illumination from either the first or the third quarterly Moon is only about 1/10th as intense as that from the full Moon

Tides

The periodic rise and fall of the Earth's water is called a tide, although the same process also occurs in both land and air The solid Earth as a whole is about as elastic as steel and air is more pliable than water Each day a high tide, or rise of Earth, water, and air, occurs after the Moon crosses the midline of the sky High tide occurs about 50 minutes later each succeeding day because the Moon moves $12\,2^{o}$ in its orbit each day. The water has a horizontal ebb and flow throughout the day due to the Moon pulling obliquely everything not directly underneath

Each month, high tides occur and can be credited to the mutual attraction between Moon, Sun and the Earth If a straight line be imagined between these three objects, at new or full Moon water mass of the Earth is raised most by the forces of attraction These spring tides of the year closest to the solstices are produced chiefly by the nearest object, the Moon The tides are due to the difference between the Moon's pull at the

centre of the Earth and its pull at other points The Sun's attraction is greater but the difference in its pull at different points of the Earth is negligible, the Sun's much greater distance prevents much differential pulling The Sun is less than half as effective as the Moon in raising tides When two straight lines be imagined connecting Earth, Moon, and Sun, (particularly two straight lines perpendicular to each other) tides are smaller Neap tides result from the Moon and the Sun attracting Earth and its parts in different directions

	Moon
	⁝
Sun ------< Earth > -------Moon	Sun -------Earth
Conditions for Spring tides	Conditions for Neap tides

Atmospheric Tides

Regular daily variations in atmospheric pressure, of a world wide character, are called atmospheric tides, although they are due to solar heating as well as to the gravitational pull of Sun and Moon Unlike ocean tides, atmospheric tides have the Sun, not the Moon, as the main controlling agent Day time solar heating and night time cooling are responsible, respectively for pressure minimums (low tides) at 4 a m and 4 p m), and maximums (high tides) at 10 a.m. and 10 p.m local standard time Variation from the normal pressure for the ranges from 0 3 mb (millibars) near the poles, to about 1.5 mb in the tropics (*International Encyclopedia of Science*)

CHAPTER 5

CELESTIAL CONNECTIONS

Planets are observed to move sometimes eastward among the stars (direct motion), and sometimes westward (retrograde motion), the rate being variable for each planet These apparent motions are a combined effect of the planets revolution around the Sun as seen from Earth which is revolving around the Sun The combinations of the orbital motions of Earth and of any other planet give rise to complicated apparent motions of the planets as seen from the Earth Because the main orbits of the main planets are, except for Pluto, slightly inclined to the plane of the orbit of Earth, the apparent paths of the planets (except Pluto) are restricted to zodiac, a belt 18^{o} wide centered on the ecliptic The ecliptic is the path in the sky traced out by the Sun in its apparent annual journey as the Earth revolves around it The apparent motions with respect to celestial sphere, that is to fixed stars, appear for the inferior planets as oscillations back and forth about the position of the Sun steadily moving eastward For the superior planets, the apparent motion is generally eastward or direct but for short periods, near the time of opposition, it is westward or retrograde The inferior planets are those with orbits inside 'Earth's orbit and superior planets

are those with orbits outside Earth's orbit

Planetary orbits are subject to two classes of perturbations caused by either gravitational or non-gravitational forces secular or long term perturbations Secular perturbations, are called because they are either progressive or have excessively long periods, arise because of relative orientation of orbits in space Periodic perturbations arise from the relative positions of the planets in their orbits When the disturbed or disturbing planets are aligned on the same side of the Sun, perturbation reaches a maximum, and reduces to minimum, when alignment is reached on opposite sides of the Sun

In course of their motions around the Sun, Earth and other planets occupy a variety of relative positions or configurations The inferior planets are in conjunction with the Sun when close to the Earth-Sun direction either between the Earth and the Sun (inferior conjunction) or beyond the Sun (superior conjunction) Between these conjunctions, the geocentric angular distance from the planet to the Sun, or the elongation, varies up to a maximum value The superior planets are so limited, and their elongations can reach up to 180° when they are in opposition with the Sun

For an inferior planet four configurations have been recognized·

(a) Inferior conjunction - when it is directly or almost directly between Earth and Sun

(b) Superior conjunction - when the Sun is between Earth and the planet, and greatest elongation east and west, referring to the planets greatest angular separation from the Sun in the sky An inferior planet exhibits phases like the Moon's, being full at superior conjunctions showing half its disc at greatest elongation, and being new at inferior conjunction.

A superior planet shows these four configurations

Conjunction When the Sun is between Earth and planet. Opposition When Earth is between Sun and planet and hence nearest to the planet, and east and west quadrature, in each of which the directions of the planet and the Sun are at right angles as seen from the Earth A superior planet is full at opposition or conjunction, its phase defect is greatest at quadrature, when the planet is gibbous With elongation 0^o, the planet is said to be the aspect of conjunction

The super conjunction refers to an apparent alignment of all or most of the planets within a small angular span When there is a near alignment of all the planets on the same side of the Sun, it is said to be heliocentric superconjunction On the other hand, when all the planets, the Moon and the Sun are lined up on the same side of the Earth, it is said to be a geocentric superconjunction Whenever, the planets, in such an apparent get together, are separated by a very small angle of say, 2^o to 5^o, the event offers a grand space spectacles But, unfortunately, the typical angular separation are not less than 50^o and the planets, in such cases, remain so scattered that the event hardly attracts any attention

In other words, the configurations of the planets have been defined as such, conjugation - when two planets are in the same part of the sky, opposition - when they are in opposite part of the sky, square - when they are at right angles to each other (Seymour, 1988).

Interplanetary Relationship

The relationship between the Sun and the planets and among the planets themselves can be best understood in terms of physical forces arising out of the mutual gravitational effects, the mutual magnetic fields, or through direct emission of light, heat, energetic particles etc Had there been no solar radiation, no life could have evolved on the surface of the Earth

Radio outbursts, sunspots, flares, plages, prominences on the Sun affect the terrestrial radio communication, produce auroral glows, near the poles, increase the atmospheric mass movement, increase the positive ions in troposphere, raise the rate of precipitation and temperature, alter the geomagnetic field and ionosphere, change the level of atmospheric ozone, ionospheric heights, spin rates of Earth To understand the interplanetary interactions, it is worthwhile to make a survey of different interplanetary forces

The solar system consists of the Sun, the planets, their satellites, asteroids, etc, all surrounded by a very tenuous interplanetary medium Gravitation binds and stabilizes the entire solar system More than 99 5 percent of the total mass of the solar system is concentrated in the Sun The Sun radiates electromagnetic energy in practically all wavelengths from 300m radio-waves down to X-rays of less than one Angstrom Many transient phenomena like flares, sunspots, prominences have been noted on the Sun's disk (*Science Today*, Feb 1980)

Being opaque, planets can only reflect a tiny fraction of the total light, expressed in terms of albedo The reflection is rarely mirror like, usually the reflected radiation is scattered in many directions The albedo or ability of reflection of different planetary surfaces are Earth as a whole 0.34 (with high contribution from clouds with albedo 0.75), Moon:0 07, Venus 0 61, Jupiter.0 41, and Saturn.0 42

In nature, the magnetic fields are extraordinarily diverse both in size and in the effects they produce The magnetic field of the Earth, which forms the Earth's magnetosphere, extends to a distance of 70,000-80,000km in the directions of Sun and for many millions of km. in the opposite direction. Near the surface of the Earth, the magnetic field is equal to an average of 0 5 gauss and at the boundary of magnetosphere is of order of 10^{-3} gauss. The geomagnetic field shields the surface of the Earth and biosphere from the flux of charged particles

in solar wind, and in part, from cosmic rays. The geomagnetic field influences the biosphere

Direct measurements by means of spacecrafts have demonstrated that the heavenly bodies closest to the Earth - the planet Venus - do not have an intrinsic magnetic field similar to the Earth However, the analysis of rocks, both crystallized and breccia, shows possession of remnant magnetization on Moon No dipole magnetic field in excess of 5 gammas had been detected by the lunar orbiting satellite. In contrast, magnetometer landed during the Appollo Missions indicated local magnetic field upto 300 gammas The Appollo 15 and 16 satellites also had indicted complex magnetic anomalies up to 1 gamma on Moon

Of the other planets in the solar system, only Mercury, Mars, Saturn, and especially Jupiter have intrinsic magnetic fields sufficient to create planetary magnetic traps A magnetic field of up to 10 gauss and a number of characteristic phenomena (such as magnetic storms and synchrotron radio frequency radiation) that indictes the significant role of magnetic fields in planetary processes have been found on Jupiter

The interplanetary magnetic field is primarily the field of the solar wind (the continuously expanding plasma of the solar corona). Near the Earth's orbit the interplanetary field is of the order of 10^{-4}-10^{-5}gauss. The lines of force of the interplanetary magnetic field have the shape of uncoiling spirals that emanate from the Sun (their shape is due to the addition of the radial motion of the plasma and the Sun's rotation) The magnetic field of the interplanetary plasma has a serial structure, in some sectors it is directed toward the Sun, and in others, away from the Sun. The regularity of interplanetary magnetic field can be disrupted by the development of various types of plasma instability, the passage of shock waves, and propagation of fluxes of fast particles produced by solar flres (Aslamozov, *et al.*, 1977).

Sphere of Influence

The sphere of infleuence of a celestial body is the region in space where the gravitational attraction of the body predominates over the attraction of all other celestial bodies The sphere of influence (P) of planets can be expressed as $P=a5\sqrt{m^2}$, a=semi major axis of the planets orbit, m=mass of the planet divided by mass of the Sun The value of P for different planets is presented in table 4

Table 4

Sphere of Influence of the Planets

Planet	Distance from the Sun	P(AU)
Mercury	0 307-0.4667	0 001
Venus	0 7233	0 004
Earth	1 0	0 006
Mars	1 381-1 666	0 004
Jupiter	5 203	0 322
Saturn	9.539	0 364
Uranus	19.182	0 346
Neptune	30 058	0.580
Pluto	29.65	0.18-0 30

(AU = 92880000m)

The value of P for the sphere of influence of the Moon is approximately 66000km. (*Great Soviet Encyclopedia*).

Tidal Effects

The computed tidal effect of planets is given in table 5.

Table 5

Tidal Effects of the Planets on the Sun

Planet Effect	Distance from the Sun	Mars	Tidal
Mercury (Perihelion)	0 3075	0 055	1 89
Mercury (Aphelion)	0 4667	0 055	0 54
Venus	0 7233	0 8150	2 15
Earth	1 0	1 0	1 0
Mars (Perihelion)	1 381	0 1074	0 041
Mars (Aphelion)	1 666	0 1074	0 023
Jupiter	5 203	31 89	2 26
Saturn	9 539	95 17	0 11
Uranus	19 182	14 6	0 002
Neptune	30 058	17 2	0 0006
Pluto (Perihelion)	29 65	0 08	0 000003

(After Rana, 1981, *Science Today*)

Planetary Configurations, Sunspots and *Kumbha*

Being opaque, planets can only reflect a tiny fraction of the total light output of the Sun and also have a nominal radiative influence on each other For tidal effects, this figure is even less, about a millionth of the Sun. Similarly, the sphere of influence of planets is also very small as compared to the Sun. Among the planets only Jupiter has a moderately strong magnetic field which is responsible for emission of energetic electrons into interplanetary space. Even then the magnetic field effects of Jupiter on Earth are less than a few percent of that of the Sun's. Therefore, we do not understand how the planets could affect life on Earth as suggested in picturesque terms by astrologers in general and at *Kumbha*, in particular.

Now if the above forces were to have some bearings

on the vigour (as well as the triggering) of the solar activities, the superconjunction of only four planets Jupiter, Venus, Mercury and Earth - which exert an important tidal effect on the Sun, would be sufficient For the sum total effect of the other planets on the Sun is negligible, being less than one percent of the total These four planets come to a near superconjunction every 11 08 years During this period, Mercury and Venus make 46 and 18 revolutions, respectively round the Sun While the Earth and the Jupiter remain symmetrically at about 27^{o} on either side of line of conjunction, it is only once in 179 years that Earth and Jupiter can also conjoin Mercury and Venus within a few degrees, say about 25^{o}

Since Jupiter contributes most to tidal effects, the major periodic enhancement of the amplitude of the solar tides due to the planet has been called the "Jupiter Effect" As shown in table (4), the value for the sphere of influence of Jupiter alone is considerably high Thus the tidal, magnetic and gravitation forces of the Jupiter alone can exert influence on the Sun and the effect may trigger on the solar activities

The position of the Earth in its orbit also affects the sunspots; when the Venus and Earth are on the same side of the Sun, their effect on sunspot is combined At the same time, the Earth is subject to bombardment by galactic particles such as Alvarez's cosmic rays Similarly, other planets do affect the sunspots, depending upon their various parameters

Since the average periodicity of the solar cycle (11-12 years), near superconjunction of Jupiter, Venus, Mars and Earth (11 08 years) and the *Kumbha Mela* (11-12 years) almost synchronize, the *Mela* seems to be based on the cosmic effects of solar activity due to these planetary alignments In all, the Jupiter effect on the Sun is a vital factor, the effects varying according to the orbital positions of the Jupiter in course of its 11.9 years circuiting period around the Sun

Jupiter Effect and Solar Activity

The process by which sunspots are formed is still a mystery There are two theories, however the first, accepted by most astronomers, is that sunspots are caused by an internal process in the Sun, probably having to do with some slow magnetic oscillation The second theory advocates that they are caused by forces exerted upon the Sun by the planets There is no appropriate reason why sunspots should not be generated by an interior mechanism but influenced in their timing and movement by planetary forces As an analogy, it would not be true to asssume that the way the Earth spins in space sets up winds in its atmosphere The driving energy to winds comes from the heating of the air at the equator and its cooling at the poles Nevertheless, the Earth's rotation does influence wind direction, causing for example, cyclones to rotate clockwise in the southern hemisphere and anticlockwise in the north Something of this sort may also be true for sunspots and their interaction with planets The major objection to the planetary theory lies in that the forces involved seem to be too weak to exert any effect Presumably, these forces would have to be gravitational, since planetary motion is exactly explained by gravity alone and any electromagnetic or other force must therefore be negligibly small The gravitational force exerted by the planets on the Sun's surface has been estimated to be a million millionth of the Sun's own gravity, hence to expect them to have any significant influence is like expecting a plane to become unbalanced upon colliding with a particle of sand However, as Dean *et al.* (1977) suggest it is much too simple to view the solar system as a mere collection of small inert weights circling a large inert one. The Sun is a liquid, it rotates faster at the equator than at the poles and the plane of its rotation differs from the plane in which the other weighty planets revolve. Thus, in complex and unstable conditions a very small force may be enough to

trigger off an event that may already be on the verge of happening

There is also the question of angular momentum Although the Sun is by far the most massive body in the solar system, it only accounts for two percent of the system's angular momentum, the remaining 98% residing in the planets Morth and Schlamminger (1979) suggest that gravitational force between the planets causes mutual perturbations of their orbits and this may cause a periodic transfer of angular momentum within the solar system This, in turn, could affect the pattern of vortices on the Sun's surface, which is of relatively low inertia and hence would be the first solar material to respond

However, if one is to find support for the planetary theory of sunspots, one should first point to some planets or combination of planets whose periods of motion round the Sun coincide with the timing of sunspots in their emergence, their latitudinal passage and the occasional lulls such as the Maunder Minimum. In this regard, the findings of Dean *et al.* (1977) deserve special attention Although Dean *et al.* have explained their theory with reference to several combinations of planetary motion, in the present study their explanation with reference to Jupiter alone has been taken into account, because of its significant effect on solar activity and special place in *Kumbha* astrology Dean *et al.* suggest that the main causative factor is a massive planetary resonance whose period is centered on the movement of the mid-point of a line joining Jupiter and Neptune, a movement which has remained in synchronization with the solar cycle over the entire 320 years for which records of sunspots exist (Fig 12).

Fig. 13 reveals that the midpoint of Jupiter and Neptune sweeps in an orbit round the Sun, but the plane in which this orbit lies is not the same as the plane of the Sun's equator. Consequently, the midpoint passes through the equatorial plane at only two points, A and B, and does so at the time of maximum activity of the

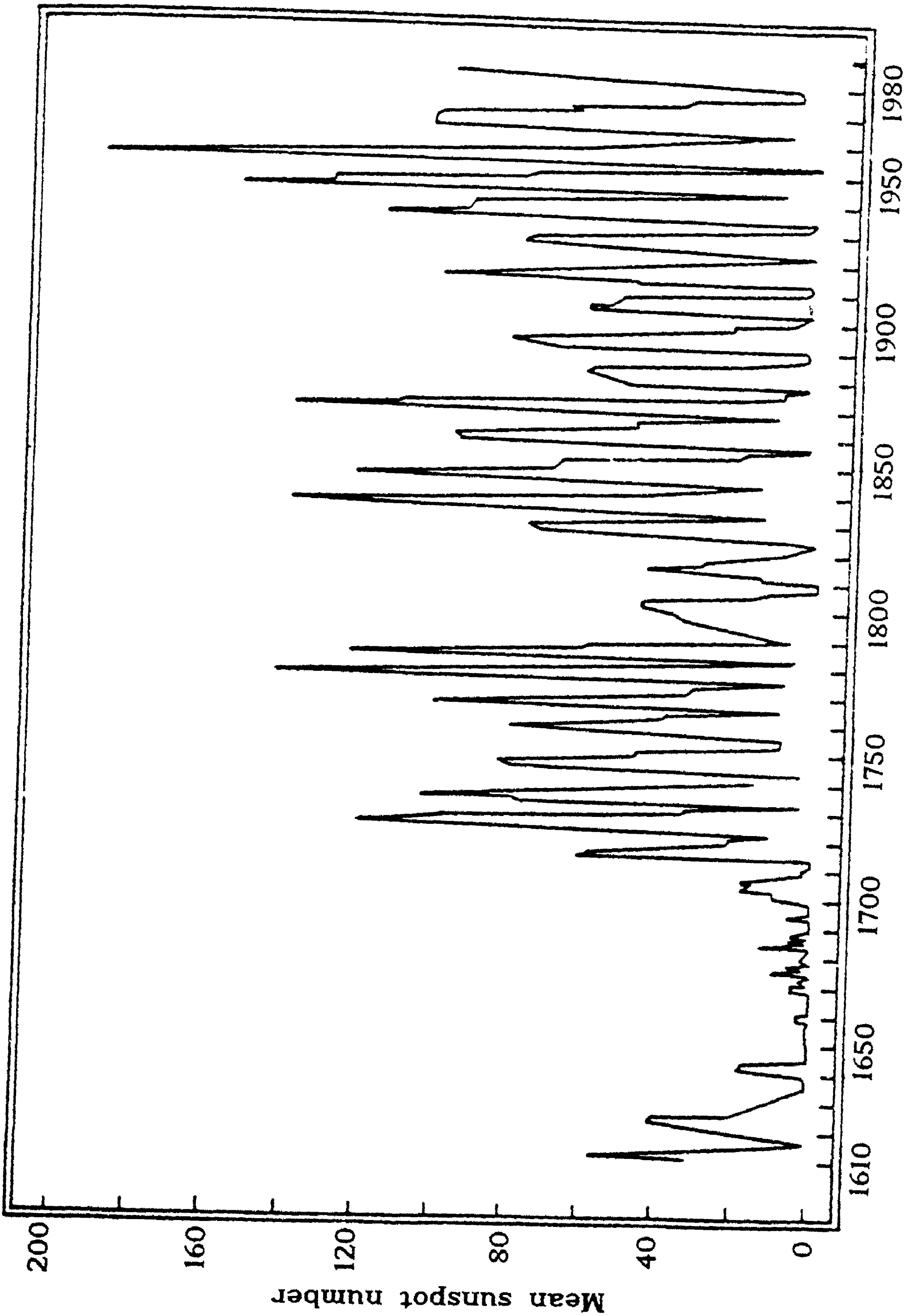


Fig. 12. *Solar Cycle*

PLANETARY FORCES

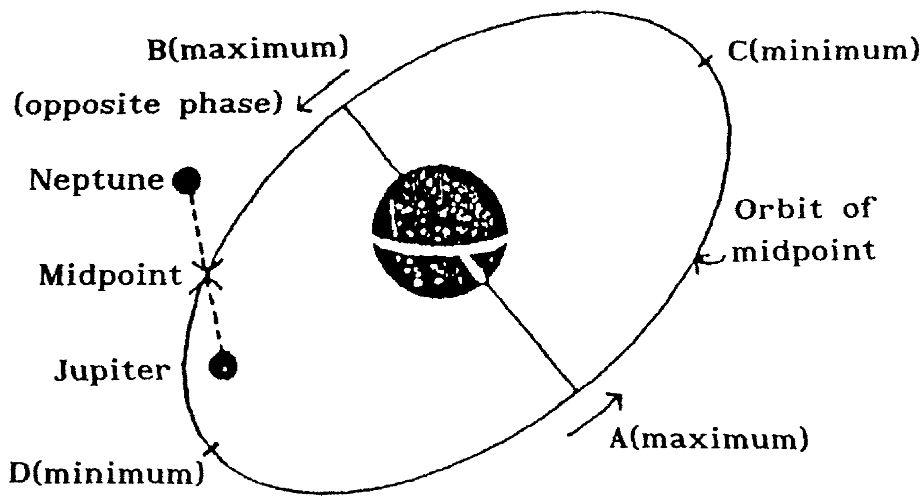


Fig. 13. *The midpoint of Jupiter and Neptune moving in orbit round the Sun. The plane in which this orbit lies is tilted compared with the plane of the Sun's equator so that the midpoint passes through the equatorial plane at two points only, A and B. As it passes through each of these points, the sunspot cycle reaches its maximum*

11 year solar cycle The times when the midpoint is farthest away from the Sun's equatorial plane, in turn, coincide with periods of minimum sunspot activity

This theory further explains the reversing phenomenon of magnetic polarity with reference to the sweeping of midpoints A & B

The most interesting part of Dean's theory is that the orbital periods of various planets or of the midpoints of two or three planets, are in "Harmonics" with the period of the Jupiter and Neptune mid-point In this way, it appears that the effects of different combinations of planets resonate with each other, producing regular periodic peaks when the critical point on one orbit coincides with that of another, and troughs when they diverge Further, Dean also mentions other planetary combinations whose rhythms appear to relate to the sunspot cycle, and as such his theory apparently poses a serious challenge to modern astronomy

Sunspot Cycle and *Kumbha Melas*

Sunspot

It is rare for the Sun to be without spots In fact there can be several hundred spots on it at any given time The largest of these curious patches cover an area many times that of the Earth. Sunspots are abnormally cold areas on the Sun's surface and are associated with high magnetic intensity Although they radiate less visible light than the surrounding areas of the Sun, they do emit large amounts of radiation and charged particles. The radiation takes about eight minutes to reach the Earth, whereas the charged particles take a day or more The presence of spots is also associated with an increase in the strength of the solar wind. The latter is a constant outward stream of ionized gases from the surface.

The spots are continuously appearing and disappearing. Their life span is highly variable, some surviving only for a few days, while others last for

well over a month But taken altogether they form a cyclic pattern which rises to a peak of activity on an average of every 11 1 years The cycle is irregular and the interval between peaks ranges from 7 to 17 years, but a short interval is usually followed by a prolonged one to maintain a balance and over an extended period of time the average length of the cycle works out to be slightly constant. During the 13 cycles of reliable data since 1848, the cycles length has varies between about 10 and 12 years (Foukal, 1990) The cycles amplitude has been even less regular, ranging from an annual mean spot number of about 45 in 1804 and 1818 to a peak of roughly 190 in 1957 (Foukal, 1990)

Sometimes the cycle is broken and for a time the usual peaks fail to appear This event was recorded between 1645 and 1715 A.D and again during 1400-1510 A.D and is known as the Maunder Minimum, named after Walter Maunder, Superintendent of the Royal Greenwich Observatory in London in 1890 A.D In the recorded history of the past 5000 years, the recurrence of Mounder Minimum has been traced every 500 years or so (Eddy, 1976)

Sunspots always occur in pairs or groups of pairs on each side of the solar equator (like the Earth, the Sun rotates on an axis and hence has poles and an equator) At the beginning of one of the 11 year cycles of activity the spots first appear at about latitudes 30^{o} north and 30^{o} south. As the cycle proceeds, they begin to appear nearer to the solar equator, until at the end of the cycle and commencement of the next one, the spots resume their emergence in 30^{o} latitudes This phenomenon is known as 'latitudinal passage' Strictly speaking, a complete cycle lasts on an average 22.2 years, because throughout each of the 11.1 year-cycle the magnetic polarity of the leading spot in each hemisphere is the same and opposite to that of leading spots in the other hemisphere. At start of a new cycle, these polarities reverses (Fig. 14)

A retrospect into the periodic history of the *Kumbha*

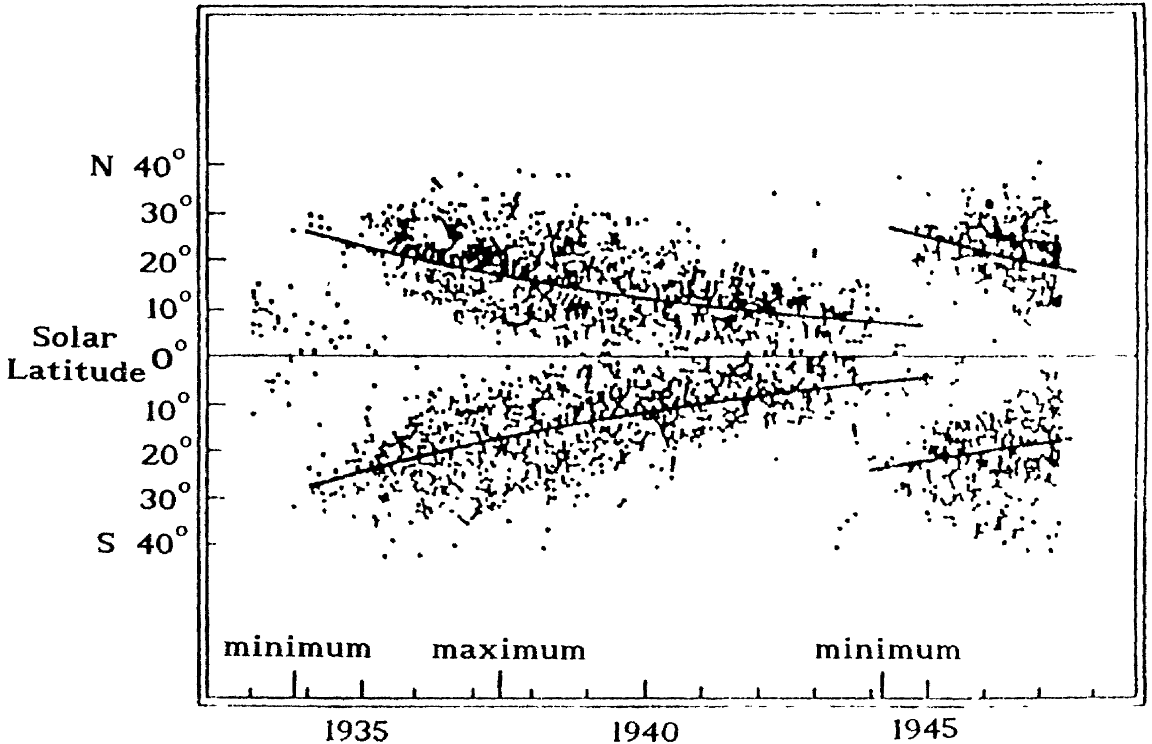


Fig. 14. *The sunspot cycle, showing how spots tend to appear closer and closer to the Sun's equator until, at the time of minimum activity, they begin to appear once again around 30 degrees north and south (Based on Abetti, 1963).*

and the solar cycle reveals that the former follows the rhythms of the latter The *Mela* at the above four places recurs at different stages of each solar cycle During 11-year magnetic fluctuation the Sun varies in its output of visible and ultraviolet light, X-rays, γ-rays, ELF (extra low frequency waves) and charged particles These fluctuations can heat and expand the Earth's upper atmosphere, cause auroras, knock out power lines, affect radio communication and reception, change the level of atmospheric ozone, raise the rate of precipitation, alter the geomagnetic field, spin rates of Earth and ionospheric heights These phenomena produce several bioeffects, varying with the magnitude of the former due to variable planetary combinations as discussed in the *Kumbha* astronomy

It has been noted that when Venus, Earth, Mars, Jupiter and Saturn are almost in straight line with Sun, or when they make 90° angles with each other, as seen from the Sun, the cosmic effects on Earth become very powerful resulting into disruption of radio communication and reception And the angles 30°, 60°, 120° or 150° between these planets, as seen from the Sun, are very powerful for cosmic effects on Earth At other angles the effects are mild in nature (Seymour, 1988)

The *Kumbha Mela* occurs at Hardwar, Prayag, Ujjain and Nasik, when Jupiter lies in Aquarius and Sun in Aries, Jupiter in Aries and Sun and Moon in Capricornus or Sun in Capricornus and Jupiter in Taurus, Jupiter in Leo and Sun in Aries or Saturn in Libra and Sun and Moon in the same part of the sky, and Sun and Jupiter in Leo or Jupiter, or Sun and Moon in Cancer

The planetary configuration for the Hardwar represents square For the *Mela* at Prayag, the Sun and Moon are in conjugation and Jupiter and Sun are separated approximately by an angle of 120° or Sun and Jupiter are separated by an angle of 60° The *Mela* at Ujjain occurs when the Sun and Jupiter are in different part of the sky and separated by an angle of 60° or Sun and Moon being in the same part of the sky representing

aspects The *Mela* at Nasik occurs when Sun and Jupiter or Sun, Jupiter and Moon show conjugation

Planetary Terrestrial Effects

The planetary configuration for Hardwar, *Purna Kumbha* is suggested to lead to the development of *Tamasi* attitudes, disruption of socio-religious norms among the people and their suffering from many diseases The influence of planetary configuration for the *Ardha Kumbha* there, on the contrary, results into amiable socio-religious environments and receptivity of people to faith and religion (Saravali 26,9-10) The planetary influence of the *Purna Kumbha* at Prayag results into amiable environments and propensities towards gods and *yogik* meditation The influence also serves as a harbinger for change of the government (Saravali 22/56-57-1-2).

The planetary influence of Nasik *Kumbha* depends upon associated planets and their cosmic positions If aspected by Mercury and Venus, the cumulative influence promotes the development of socio-religious norms and scientific temperaments among the people, otherwise there might be contrary influence (Saravali 26/49-54) The planetary configuration for *Kumbha* at Ujjain, if aspected by favourable planets may develop *Satvika* feeling and helps people attaining *Dharma, Artha, Kama* and *Moksa,* if aspected by unfavourable planets, it may lead to shattering of socio-religious norms and disorders in human health and relations

Because of enormous distance between the planets and insignificant mangitude of gravitational and electro-magnetic forces, the *Kumbha*'s cosmobiology and other astrological propositions are generally discarded by modern scientific minds But there are difinite astrological and non-astrological evidence showing planetary effects and cosmic connections, as mentioned below

The pioneering research into biological rhythms has

shown that solar radiation and lunar cycles together with other cosmic events, do indeed have their influence on life on Earth in completely non-astrological ways, such phenomena have become established as an area of science known as cosmobiology Playfair and Hill (1978) assessed the evidence from over 300 such studies out of a total now reaching 20,000 These cover such areas as the planetary effects on the weather to possible galectic influences on certain biochemical reactions In the majority of cases, the basic mechanism of the influence is known or suspected to be electromagnetic in origin

Michel Gauquelin (1976,1980,1982) has produced a large body of data supporting relationship between planetary positions (Moon, Venus, Mars, Jupiter and Saturn) and the births of certain groups of eminent professionals He observed that different planets occur significantly more often, or in certain circumstances significantly less often, in birth charts of famous professionals very near to either of two traditionally sensitive points in horoscope, or birth chart These points are, one, just after a planet has risen over the Ascendant (the Ascendant is where the projected eastern horizon for any locality cuts the ecliptic or plane of the Earth's orbit) and two, just after the planet has reached its upper culmination at the "Mid-heaven" (the Mid-heaven is where the upper meridian, or the plane passing through a given terrestrial location and the Earth's axis, cuts the ecliptic). For example, Mars was found to fall in either of these sectors significantly more frequently than would be expected in the birth charts of sportsmen, whereas in those of eminent scientists, the planet involved was Saturn

These and the other associations observed usually involved the planet traditionally linked with the profession in question but were only found with those professionals achieving a high degree of eminence in their respective fields. Similar results were not obtained with the corresponding non-eminent profess-

ionals The significance of Gauquelin's results reached a probability of 1 in 10,000 in many cases and in one case reached a probability of 1 in 1,000,000 as shown in table 6 (Gauquelin, 1984)

Table 6

Frequency of planets in sectors 1 and 4 of the diurnal circle for famous professionals

Group	Planet	Computer results (rise/set sectors)			
		Exp	Act	Diff	Prob
2088 Champions	Mars	358 5	435	+ 76 5	0 00002
3647 Scientists	Mars	626 2	703	+ 76 8	0 001
	Jupiter	602 5	547	- 55 5	0 05
	Saturn	598 0	685	+ 87 0	0 0001
3438 Soldiers	Mars	590 3	662	+ 71 7	0 002
	Jupiter	575 1	686	+110 9	0 000001
5100 Artists	Mars	875 7	773	-102 7	0 0002
	Saturn	828 0	744	- 84.0	0 003
1409 Actors	Jupiter	234 0	273	+ 39 0	0 01
1003 Politicians	Jupiter	166 4	202	+ 35 6	0 002
1352 Writers	Moon	225 4	288	+ 62.6	0 00001

Total no of sectors = 12 Sectors 1 and 4 are just past rise and culmination respectively. Exp. = Expected frequency, Act = Actual frequency, Diff. = Act. - Exp , Prob = Significance level of the differene by two tailed Critical Ratio test

However, Dr. Percy Seymour (1986) invoking the phenomenon of resonant amplification, proposed a model in which the planets resonate with the Sun's magnetic canals. These are caused by differential rotation, which affects the solar activity, which affect the magnetic field. This, in turn, is considered to effect the propagation of human nerve impulses. McGillion has

outlined a plausible involvement the pineal gland in such effects, with its sensitivity to weak magnetic field changes (McGillion, 1980) While Landscheidt (1989) has produced considerable evidence supporting a strong causal link between the planets, solar activity and terrestrial events

The probability that electromagnetism may at least in part, explain his results is reinforced by Gauquelin's additional discovry of what he terms a "planetary hereditary effect", which is based on 30,000 French parents and children He notes that if one or both parents had been born when either the Moon, Venus, Mars, Jupiter or Saturn was just past the Ascendant or Mid-heaven, the same planet or planets occurred very significantly (with a probability of greater than 10 parts in a million) more often in one of these positions in the charts of their children (Gauquelin, 1966, 1982, 1983, 1986, 1988b) Although a fully satisfactory replication is yet to be done, a further interesting finding was that the correlation was observed to increase on geomagnetically disturbed days Using the index Ci as the magnetic character index on a scale of 0 0 to 2.0, the planetary effect was twice as strong when a child was born on day when Ci was equal to or greater than, unity

Taking the Gauquelin's findings a step further to examine any mediating psychological variable, Eysenck (1975) predicted certain links between the personality descriptions of eminent professionals He found Saturn linked with introversion and Mars and Jupiter with extroversion The introverted professionals were found to have been born significantly more frequently when Saturn had just risen or had just passed its culminations, extroverts were born when Mars and Jupiter were in these positions (Gauquelin, 1979) These findings suggest that it is personality which is related to planetary position at birth rather than profession, and that the profession is related to the planetary position through the intermediary of personality. All of which

suggests that eminence may be as much a matter of personality as innate ability Stark (1986, 1987) has provided preliminary confirmation of similar planet-personality correlations with ordinary people

Chemical Reactions

Piccardi (1962) records that the chemical reaction rate rose three and half times on the days of solar eruptions and that it was also affected by strong magnetic storms and the 11-year sunspot cycle Inexplicable annual variations were also observed, including a noticeable decline and a sudden enhancement in March, with another around September equinox Piccardi (1962) postulated that galactic forces were responsible for such effects through a combination of Earth's rotation, its orbit around the Sun and its helical movement through space (at about 19 km/sec) towards the constellation Hercules Concluding on the variation of the Earth's helicoidal motion, which reaches its maximum velocity of 45 km/sec. in March and its minimum in September, Piccardi mentions

> "During March, and only during March, the Earth is directed approximately, at maximum speed, towards the galactic centre that is, along the lines of force of a radical field and perpendicular to the lines of the force of a dipolar galactic field This double condition will not be encountered again throughout the year The conditions during March are thus quite exceptional" (Piccardi, 1962)

The studies of Brown established that there is a definite effects of lunar cycles on plants and animals. Brown (1962) showed how the metabolic activity of potatoes, carrots, earthworms and nuts, as measured by oxygen consumption, depend on the lunar diurnal rhythms Bradley *et al.* (1962) and Adderley and Bowen (1962) confirmed that rainfall in both the hemispheres exhibit a lunar periodicity. Brown and Chow (1973) demonstrated that water uptake by bean seeds peaks significantly just

before full Moon Brown (1954) also found that valve opening and closing of oysters is closely related with lunar rhythms

Brown also investigated the effects of weak radiation upon various organisms and, with Park (Brown and Park, 1967), showed that mammals as well as marine life are influenced by pervasive, weak geomagnetic fields Based on the evidences for extrinsic timing of internal rhythms in animals and plants, Brown (1972) concluded, "No clear boundary exists between the organisms metabolically maintained electromagnetic fields and those of its geophysical environment" He attributed the external effects to temperature and light or ELF electromagnetic fields (1983) Harold Burr (1945) studied the variations of the electrical potential of trees and noted that they followed the lunar cycle and were also affected by the sunspot number As early as 1935, Burr had expounded, with professor Northrop, his Electro-dynamic Field theory of life, postulating that all organisms possess an organizing electrical field (of potential gradient, a so-called "L field") independent of local conductivity variations or ion currents in the tissues Burr assumed that electromagnetic fields had shaped the myriads of different life forms on the Earth He and his colleagues claimed that an "L-field" exists long before the organism is fully grown, can be picked up at a distance from the organism and that, although normally steady, can be affected by external factors such as ELF waves and solar and lunar cycles. He later noted that the "L-field" changes in response to pathological processes and that monitoring such changes permits diagnosis of internal disease states, long before they become manifest (Burr, 1972).

Ravitz (1951) observed changes in the electrical potential between head and chest in humans, in which the subjects showed a 14 to 17 day cycle in rough correlation with the lunar phases, as well as longer periodicities. In a comprehensive review of the evidence for an electrodynamic field theory, Ravitz (1962)

reported that Schizophrenic and manic depressive patients exhibited seasonal oscillations and the several studies had shown a correlation between onset and change in psychotic episodes and different phases of the Moon The most striking tides in environmental electric fields showed diurnal, 14 to 17 day, 28 to 29 day, seasonal and semi-annual variations According to Ravitz, electro-magnetic fields act as determinant of biological activity, rather than as epi-phenomena, patterning the nervous system and regulating every component part of it from within and without, they define living matter in terms of four dimensional time-space and energy

During recent past, a team of Soviet scholars has provided independent corroboration of Burr's and Ravitz's ideas According to *Times* (Wiseman, 1987), the group of Yuri Gulyayev analysed electromagnetic radiation as well as audible and ultrasonic sounds from the body Besides recording for the first time, the strength and spatial distribution of fields around the human body, the Soviet team began to establish how people react to the field generated by another person. They found that one person can sense changes in the infrared radiation emitted by another. After collecting data covering 2400 years, Chizhevsky (1934, 1971) claimed that it showed that the World's major mass movements, including all wars, uprisings and social movements, revealed regular cycles linked to sunspot cycle. The peak in popular unrest coincided, in nearly every case, at or near the year of maximum solar activity. He claimed that mass excitability linked to each solar cycle could be divided into four phases – minimum, increased, maximum, and declined which matched the progress of each solar cycle Chizhevsky found that nearly 80 percent of all major events in modern history occurred in phases 2 and 3 and only 5 percent in phase 1. Some examples of the former include the French revolutions of 1789, 1830, and 1848, the commune of 1870, the two Russian uprisings of 1905 and 1917, and the outbreak of the second World War in 1938 (Playfair and Hill, 1978). More recent examples include the

invasion of Czechoslovakia and the world-wide student unrest in 1968, the invasion of Afghanistan in 1979 and the Falklands war in 1982 The peak of next solar maximum is to occur in 1992 or so (Foukal, 1990), the effect of second phase and the near maximum is evident from world-wide war-situations, that culminated into Iraq-America war in 1991, social tensions, student unrest, political instability in India and else where The effect of 1992 sunspot maxima will cause disastrous effects in the months of March and December 1992 on socio- political and religious set up of India and elsewhere in other months During its decline phase i e 1993 and 1994 more or less similar ill effects will be observed world over in general and in India in particular

The Sun and Moon, extra terrestrial ELF (1-300 Hz), and Circadian rhythms

The Moon has long been suspected influencing mental stability in humans A "Lunatic" was said by Paracelsus to "grow worse at the dark of the Moon" Later on, the lunar infuence has been confirmed in many biological systems, including plants (Sweeney, 1969, Kollerstrom, 1980), agriculture (Currie, 1988), fish (Bunning, 1964), rodents (Klinowska, 1972), and other animals (Downer, 1988) Friedman *et al.* (1965) have correlated psychiatric hospital admissions and ward behaviour statistics with geophysical parameters They note that there is an absence of a significant relationship between the total range of geomagnetic activity as measured conventionally, but that cosmic ray indexes relate significantly with both the above measures Cosmic ray activity produces a quantifiable geophysical measure indirectly related to geomagnetic activity. However, there is no sufficient data to suggest causal relationships with psychiatric illness

Lieber (1979), published a collection of many studies purporting to show a reliable lunar influence on various areas of human behaviour Rounds (1975) reported

a lunar periodicity in the concentration of neurotransmitter like substances extractable from human blood Lieber suggested a theory of gravitational biological tides as the possible mechanism of effect but the accumulated evidence indicates that an electromagnetic link is far more plausible

Electromagnetic Link

The Moon is known to modulate the Earth's geomagnetic field during its monthly twentynine and half day phase (Synodic) cycle (Bigg, 1963) Bell and Defouw (1966) demonstrated that this influence tends to peak at the full Moon, the closer the full Moon is to the plane of the ecliptic (the plane of the Earth's orbit round the Sun, i e to there being a lunar eclipse), the greater the effect The celestial latitudes of the Moon varies up to 5 degree north and south of the ecliptic, that is called its twentyseven and half day "Nodal cycle", after the two points of intersection, or "nodes" Bell and Defouw recorded that when the Moon's position in its nodal cycle is within 1 degree of the ecliptic at the full Moon (phase cycle), the effect on geomagnetic activity reaches its peak, and declines uniformly as it moves toward 5 degrees north or south of the ecliptic In view of it, only claimed effect of the full Moon on human behaviour, or other phenomena, such as, post-operative bleeding (Andrews, 1961), may well vary in its intensity according to the full Moon's celestial latitude in any given phase cycle One likely biosensor for any such effects is the pineal gland, which has been found to be extremely sensitive to changes in magnetic field and to ELF

The existence of a magnetic field at the surface of Earth has been known since time immemorial The first extensive review of the biological effects of the geomagnetic (G.M F.) field was published by Aleksandre Dubrov in 1978. The G.M.F at the surface of the Earth has a steady component of about 0 5 gauss (Orested), 50 microtesla or 50,000 gammas The actual value varies

between 0 35 and 0 70 gauss over the surface of the Earth The direction of the local field is inclined to the horizontal at the so called "angle of dip" of the compass needle Measurements on rocks indicate that the polarity of the G M F reverses every 10,000 to 100000 years and has smaller variations over a period of 100 to 1000 years

Superimposed on this steady field is a variable field component amounting to less than 2% in magnitude but very important biologically Under 'quiet' conditions, there are variations synchronized with the solar day and the lunar day, and there are also annual variations Disturbances are noted in synchronism with the 11-year sunspot cycle, and the 27 day period of rotation of the Sun about its axis The Earth's orbit is within the outer atmosphere of the Sun and experiences solar wind of radiation and charged particles, which become trapped in the Earth's Van Allen radiation belts and give rise to the auroral at the poles and to currents in the upper atmosphere which oscillates between north and south poles The Schumann Bands of ELF radiation (1-30 Hz) originate from resonances in the insulating cavity enclosed by the conducting Earth and the conducting ionosphere Magnetic storms are classed according to their magnetic field strengths, very strong, over 200 gammas; weak, 50 gammas, (1 gamma=10^{-5} Gauss (Orested) = 1 nt = 19^{-9}T) These fluctuations are well above the theoretical threshold sensitivity of man and animals These and other phenomena combine to form man's natural electromagnetic environment

In mammals, the pineal gland (Semm *et al.*, 1980) is a light sensitive, time keeping organ in which the cell activity is affected by magnetic field pulses of the order of the strength of the geomagnetic field. It seems quite possible that the pineal gland in higher animals and man may have drifted its electromagnetic sensitivity away from predominantly visible light sensitivity, characteristics of submammalian vertebrates. In the latter creatures the pineal gland, which is only covered

with a translucent layer of skin, may have had the emission of radiation to attract food as its primary purpose

Similar to radio receiver, calculation can be done in respect of detection of electromagnetic signals by living systems.

For an organ of the size of human pineal gland (Barr, 1979) to be able to respond cooperatively to changes in magnetic field, the following restrictions must apply The coherent energy of the magnetic field within the volume of pineal gland must not be less than the random thermal energy (Smith, 1985), which means that the minimum detectable magnetic field for the pineal gland is 0.24 nT or T (2 4 μG) The other limitation is set by the size of the quantum of magnetic flux. The strength of magnetic field which would give only a single magnetic flux quantum through a pineal gland comes out at 75 pT (0 75 μG) As it is smaller, the energy or signal-to-noise limit is reached before the quantum limit Honeybees (Apis) and birds are found to be sensitive to magnetic changes probably less than 1 nT (1T, 10μG) (Keeton, 1979), so that a limiting sensitivity calculated on the above criterion is not unreasonable both for humans with a 2 gram pineal gland and for pigeons with a 1 5 gm pineal gland Thus, apis should only be able to sense field below 1 nT However, all these creatures should be capable to detect the "quiet" diurnal and the disturbed variations of the G.M.F

Experiments involving the shielding of living systems from the GMF have been carried out by Dubrov (1978), in which he reports a wide range of effects Plants shielded for a prolonged period from the GMF developed histological and physiological disturbances as well as peculiar tumours Definite alterations to the biochemistry, physiology, and behaviour were found by Dubrov in a wide range of living systems ranging from insects to higher animals and man, following the high degree of prolonged total shielding. Of particular

attention in the physiological changes are reported to occur among submarine crews who spend long periods shielded from the steady GMF by a thick steel hull and from much of ELF salt water

A number of experiments have been conducted involving persons living for prolonged periods in an underground dwelling, to some extent shielded by steel from the steady GMF and from the ELF, the soil adding to the shielding from the latter In course of these investigations involving human circadian rhythms, Wever (1973,1985) found that the human circadian systems had a remarkably high sensitivity to weak ELF fields The most relevant effect observed was the field-induced shortening of the circadian rhythm and systematic alterations in all the rhythm patterns

In a constant environment without clues as to the local time, the sleep/wake activity and the deep body temperature periodicities tend to increase, eg , from a 24 hour day to 25 hour day It is remarkable that the human circadian rhythm was rated to be insensitive to changes in level of illumination, from total darkness to 1500 lux whether under voluntary or involuntary control Thus, the dark-light cycle does not seem to have the ability to function as human zeitgeber

In a number of cases, the phenomenon of internal desynchronization occurred when the free-running circadian rhythm would abruptly alter its periodicity, but with the deep body temperature retaining a 25 hr periodicity This tendency was found to be greater in subjects over to 40 to 45 years of age than the younger subjects Alterations in sleep/wake cycle of exactly half or twice the periodicity of the rectal temperature cycle were called "apparent desynchronization", because the internal coupling was as great as in the case of full internal synchronization with its 25 hr sleep/wake cycle. Apparent desynchronization was found not to be related to the 10 Hz field, or to the age of subjects. Only with internal desynchronization where the different cycles are not in an integral relationship, does the 10

Hz field have an influence (Wever, 1985) Like light as an external stimulus to animal species, the human circadian rhythm was found to be resistant to it as a timing stimulus (zeitgeber) Weak ELF was suggested to be zeitgeber for human (Wever, 1985)

Wever reports that the continuously operating, weak, 10 Hz square wave electric field could prevent or reduce internal desynchronization and affect autonous periods When it is operated periodically, it exerts a zeitgeber influence and entrain a free running rhythm into synchronism The sleep/wake cycles and the deep body temperature cycles could be synchronized simultaneously to the weak 10 Hz field at a periodicity of 23 5 hrs per day, for which there are no known natural or artificial zeitgeber in the environment Wever also presents the results of preliminary animal experiments which exhibited that animal circadian rhythm had a similar sensitivity to weak ELF He reports that specially trained birds are able to differentiate between 10 Hz field and 9 Hz field This evidence strongly supports the likelihood of interactions between coherent frequencies, circadian rhythms and their entrainments

Jacobi (1979) found an effect on thrombocytes which could only be observed with 10 KHz "Sferics" after the 10 KHz had been modulated with ELF frequency of 10 Hz Since previously drawn blood samples and exposed to the same field did not show any effect, it suggests that it is only living subjects showing the effect In other experiment it was observed that on shielding the head, there occurs no effect on blood This leads to suggest that the head contains the field sensitive region (it also contains the pineal gland)

In experiments on visual acuity, a specific enzyme concerned with the synthesis of melatonin was reported to react to weak magnetic fields (Cremer-Bartels *et al.*, 1983). Melatonin is also associated with the generation of circadian rhythms. Melatonin and the enzymes responsible for its synthesis from Serotonin have been

detected in mammalian pineal gland tissue (Ganong, 1969) The shortage of Serotonin in brain is linked with the probability of suicide It is reported that geomagnetic field variations and electromagnetic radiation could reduce the Serotonin which may thereby develop suicidal tendency (Smith & Best, 1989)

The spectrum of the Earth-ionosphere cavity resonance (Schumann resonance) covers the 1-30 Hz region (Konig, 1979) The 8 Hz component has been regarded as particularly important and generally beneficial to living systems, it also coincides with the brain's alpha rhythm (8-12 Hz). There is an equivalent power flux density of the order of 10^{-10} W/m^2 Hz in this natural Earth radiation (Gendrin and Stefant, 1964), which is greater than the threshold sensitivity for a 70 kg man and therefore strong enough to act as a potential zeitgeber

The location of magnetite deposits in bacteria and in the bone of birds, mammals and man indicates that an electromechanical torque sensor is involved and that the combination forms a magnetic compass. It has now been fully established that bone is not piezoelectric as has been thought earlier, but that the electromechanical potentials in bone arise through an electro-streaming process involving ions flowing through cavities In living systems there are additional physical mechanics which could give the extremes of electromagnetic sensitivity possessed by living systems when their regulatory systems permit, or when they malfunction The presence of ferromagnetic materials in living systems may have direction determining functions, as reported by Baker (1984, 1985a & b) The whole area of magnetite biomineralisation and magneto-reception in organisms and man has recently been extensively evaluated (Kirschvink, *et al.*, 1985).

Dubrov (1978), reports that not only does the GMF exert its effects through a weak action, or extremely low energy threshold mechanism, but that is one of the main causes of the rhythmicity in natural phenomena and

of the dissymmetry which underlies the essential left handed (laevorotatory) or right handed (dextrorotatory) characteristics of all asymmetrical chemical structures, which must exist in one of the two mirror image forms, and whose effects on living systems can be very different

While quoting another Russian, Trincher, Dubrov, (1978) mentions that water inside the cell is in a state of maximum order - in a state attainable in non-living systems only at absolute zero temperature He mentions the possibility that the sensitivity of living organism is related to biological superconductivity at the ordinary temperatures of living systems, a possibility which has been suggested by a number of scholars (Cope, 1971, 1978, Ahmed *et al*, 1975, Smith, 1985) However, Frohlich (1984, 1985) mentions that it is not necessary to postulate biological superconductivity perse because, at a more fundamental level of physics both the Josephson effect in superconductivity, and the near-quantum sensitive responses of living systems to coherent oscillations and electromagnetic fields can be accounted for by the fundamental quantised nature of magnetic field In biological system any ambient temperature superconductivity is more likely to give rise to anomalous magnetic effects because the size of the biological cell is small compared with the Debye length and the coherence length of any such effects (Smith, 1985)

The Josephson effect, which can occur in superconducting system, but which does not depend on the presence of superconductivity, only the ability of the system to respond to the quantum of magnetic flux does offer a possible physical connection between living systems and the weak electromagnetic fields of the cosmos.

CHAPTER 6

SOLAR CYCLE AND EARTH

As pointed out in the previous chapter, the Sun illumines all the planets including that of the Earth It radiates electromagnetic energy in all bands, besides cosmic rays, which chiefly consist of electrons and nuclei of atoms, largely of hydrogen These radiations impinge upon the Earth from all the directions of space and bombard other planets of the solar system variously

The cosmic rays travel with nearly the speed of light These nuclei with relativistic speeds are often referred to as primary cosmic rays, to distinguish them from the cascade of secondary particles generated by their impacts against air nuclei at the top of the terrestrial atmosphere The secondary particles shower down through the atmosphere and are found all the way to the ground and below

The primary cosmic ray particles coming into the top of the terrestrial atmosphere make inelastic collisions with nuclei in the atmosphere When a high energy nucleus collides with the nucleus of an air atom, a number of things usually occur. Rapid deceleration of the incoming nucleus gives rise to production of pions with positive, negative or neutral charge Since several

particles are created by each collision, the total number of energetic particles of cosmic-ray origin will increase with depth, even while the primary density is decreasing The uncharged mesons decay into two gamma rays, each of which subsequently produces positron-electron pair Upon passing sufficiently close to the nucleus of an air atom deeper in the atmosphere, the electrons and positrons convert their energy into bremsstrahlung, which in turn create new positron-electron pair This cascade process continues until the energy of the initial uncharged mesons has been dispersed into a shower of positrons, electrons, and photons with insufficient individual energy to continue the pair production The electrons and photons of such showers are referred to as the soft component of the atmospheric secondary cosmic rays

The high energy nucleons - the knock - on protons and neutrons, produced by primary particle collisions and a few pions collisions proceed on down into the atmosphere, where they produce nuclear interactions of the same kind as the primary nuclei, though of course with diminished energies Fluctuations in solar activities accompanied by an increase in the number of sunspots and chromospheric flares alter the intensity of X-ray, ultraviolet and radio-frequency radiations of the Sun, and also the corpuscular particle fluxes emitted by it The activities associated with the sunspot cycle often affect the Earth and its environment These are due in large part to the many electrically charged high speed particles and, also ultraviolet and X-rays emitted from the Sun during the sunspot maxima Many of these particles are trapped in the Earth's magnetic field. Others reach the Earth's atmosphere where they increase the ionic content of the Earth's radiation belt and cause bright lights called auroras around the north and south poles. The particles and rays affect the geomagnetic field and also create magnetic storms on Earth They also interfere with compasses, communications and electrical power transmissions. The cyclic variation in solar radiation affects the life processes

of the terrestrial organisms

In view of the important role played by the geomagnetic field and the radiation belts of the Earth, it is pertinent to examine the effects of sunspot cycles on these Although Earth's megnetic field is weak, it occupies a large volume, and because the energy of the magnetic field is proportional to its volume, the Earth's field plays an important role in extraterrestrial relationships It screens the Earth's equatorial region from the cosmic rays having energies of a few tens of billions of eVs, and traps charged particles in Van Allen radiation belts (Girling, 1978)

Radiation Belts of the Earth

Inner regions of the Earth's magnetosphere, in which the Earth's magnetic field retains charged particles (protons, electrons and alpha particles) possessing kinetic energies ranging from tens of KeV to hundreds of MeV, the energy of particles differs in various regions of the belts. The special configuration of the lines of force of the geomagnetic field creates a magnetic trap for charged particles and prevents the escape of these particles from the radiation belts

Particles trapped by the Lorentz in the Earth's magnetic trap undergo a complicated motion. This motion may be represented as an oscillating motion in a spiral trajectory along a line of force of the magnetic field from the northern hemisphere to the southern hemisphere and back again, with concomitant but slower displacement (longitudinal drift) around the Earth When a particle spirals towards an inreasing magnetic field as it approaches the Earth, the radius and the pitch of the spiral decrease. The velocity vector of the particle remains unchanged in magnitude and approaches a plane perpendicular to the direction of the field. At a point called the mirror point the particle reflects and begins to move in reverse direction, towards the conjugate mirror-points in the other hemisphere. One oscillation along a line of force from the northern hemisphere to

the southern hemisphere is accomplished by a proton with an energy of approximately 100 MeV in about 0 3 sec The retention time, or life time of such a proton in geomagnetic trap may be as much as 100 years, in course of which the proton accomplishes upto 10^{10} oscillation On the average, captured high energy particles complete atleast several hundred million oscillations from one hemisphere to the other The longitudinal drift occurs at a considerably reduced velocity

Depending on its energy, a particle makes a complete revolution around the Earth in a period ranging from several minutes to several days Positive ions drift in a westerly direction, whereas electrons drift in an easterly direction The spiral motion of a particle along a line of force of the magnetic field may be represented as consistency of rotation around the instantaneous centre of rotation and the translational motion of this centre along the line of force

Structure : When a charged particle travels in the Earth's magnetic field, its instantaneous centre of rotation remains on the same surface, which is known as magnetic shell (fig 15)

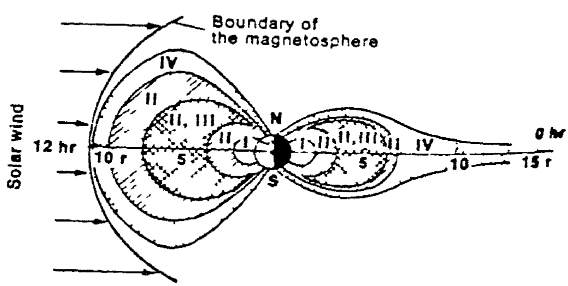


Fig. 15. *Structure of the Earth's radiation belts (the cross section corresponds to the noon meridian): (i) inner belt, (ii) low energy proton belt, (iii) outer belt, (iv) zone of particle quasicapture; (hr) hours, (r) radii (After Soviet Encyclopedia).*

The magnetic shell is characterized by the parameter L, whose value in the case of a dipole field is equal to the distance, expressed in Earth radii, separating the magnetic shell in the equatorial plane of the dipole from the centre of the dipole For the actual magnetic field of the Earth, parameter L approximates this simple physical significance The energy of the particles is related to the value for parameter L, particles with higher energy are found in shells with smaller L This is explained by the fact that high energy particles can be contained only by a strong magnetic field, that is, inner regions of the magnetosphere The Earth's radiation belts are usually divided into inner and outer belts, the low energy proton belt (ring current belt), and the particle quasicapture zone (auroral radiation zone). The inner belt is characterized by the presence of high energy protons (20-800 MeV), maximum density of the flux of protons, with energy $\geq$ 20MeV is 10^4 protons/ cm^2-sec- stere at a distance L~ 1 5 In the inner belt, electrons are also present with energies of 20-40 KeV to 1 MeV The density of the flux of electrons with $\geq$ 40KeV is maximally 10^6-10^7 electrons/cm^2-sec- stere

The inner belt is found around the Earth at equatorial latitudes This belt is bounded externally by a magnetic shell with L~2, which intersects with the surface of the Earth at geomagnetic latitudes ~45^o. The inner belt most closely approaches the surface of the Earth (at a height of 200-300 km) near the Brazillian magnetic anamoly, where the magnetic field is greatly weakened Above the equator, the lower boundary of the inner belt is 600 km above the surface of the Earth over America and as much as 1600 km. over Australia At the lower boundary of the inner belt, particles frequently collide with atoms and atmospheric gas molecules, lose their energy and, are dispersed and "absorbed" by the atmosphere

The outer radiation belt is contained within magnetic shells with L~3 and L~6 with maximum density of particle flux at L~4.5 Electrons with energies of 40 to

100 KeV and maximum electron flux of 10^6–10^7 electrons cm^2-sec Stere, are characteristic of the outer belt The average life time of particles in the outer radiation belt is 10^5–10^7 sec During the periods of increased solar activity, electrons with higher energies (1 MeV or more) are present in the outer belt

The low energy proton belt (~0 03 - 10 MeV) extends from L~1 5 to L~7-8 The zone of the quasicapture of the particle (zone of auroral radiation) is found beyond the outer belt and has a complex spatial structure as a result of the deformation of the magnetosphere by solar wind, that is, the flux of the charged particles from the Sun The major components of the particles in the zone of quasicapture are electrons and protons with energies 100 KeV. The outer belt and low energy proton belt most closely approach the Earth (At heights of 200-300 km) at latitudes between 50^o–60^o The zone of quasicapture, which is the region in above 60^o

Filling of the Radiation Belts with Particles and the Mechanism of Particle Loss

The origin of the captured particles with energies considerably exceeding the average energy of the thermal motion of atoms and molecules in the atmosphere is related to the action of several physical mechanisms These mechanisms include, (1) The decay of neutrons created by cosmic rays in Earth's atmosphere, causing protons to form and fill the inner radiation belt, (2) The "pumping" of particles into the belts during the magnetic storms, which is primarily responsible for the presence of electrons in the inner belt, and (3) The acceleration and slow exchange of particles of solar origin from the outer to the inner regions of the magnetosphere, which accounts for the filling of the outer belt and low energy proton belt with electrons The particles of solar origin can penetrate the radiation belts through special points in the magnetosphere called daylight polar cusps and through the neutral sheet in the tail of the magnetosphere (its right side).

In the regions of the daylight cusp and in neutral region of the tail, the geomagnetic field is reduced sharply and is not a significant barrier to charged particles of the interplanetary plasma The radiation belts are also filled partially as a result of the capture of the protons and electrons of solar cosmic rays that penetrate the inner regions of the magneto-sphere These sources of particles are apparently sufficient to establish radiation belts around the Earth with the characteristic distribution of particle fluxes

In the radiation belts of the Earth, a dynamic equilibrium exists between the processes of filling the belts and the processes of particle loss. Particles escape from the belts partly because of the loss of energy in ionization, this factor limits the presence of protons of the inner belt in the magnetic trap to a time $\sim 10^9$ sec. Another basic cause of particle loss is the dispersion of particles upon mutual collision and dispersion in magnetic irregularities and plasma waves of varied origin. Dispersion may reduce the life time of electrons in the outer belt to 10^4–10^5 sec These effects lead to breakdown in the conditions for the steady-state motion of particles in the geomagnetic field, and to a spray of particles from the radiation belts into the atmosphere along the lines of force of the magnetic field (Prokhorov, 1975)

Geomagnetism

It is now fairly established that Earth possess magnetic field. But inspite of tremendous increase in amounts of data and more sophisticated methods of analysis, the origin of Earth's magnetic field still remains one of the great unresolved problems. It is now generally held that origin of Earth's magnetic field lies in its fluid core, although its driving mechanism is not known with any certainty.

It has been noted that the magnetic field of the Earth reverses its polarity from time to time every 10,000 to 10,00,00 years and the field also varies

spatiotemporally over the Earth over a period of 100 to 1000 years These time changes are of two kinds transient variations and long term secular changes The transient variations are due to external causes and that of the long term secular variations are believed to originate like the main field, in the Earth's core The secular variation is partly a regional phenomena, but the north magnetic pole itself appears to be moving about 8 km northward and 1 5 km eastward The cause of the main field and its secular variations has not been finally established, but it seems possible that it may be due to currents generated by the flow of the matter in the Earth's fluid core

Superimposed on this main field are the effects of mineral deposits in the Earth's crust and the currents flowing in the ionosphere The former may cause regional anomalies greater than the normal field, while the latter, since they are very weak largely solar induced, introduce both small regular fluctuations and violent irregular ones known as magnetic storms, which like bright auroral displays and radio fade-outs, with which they are closely related, seem to be one of the results of solar flare. The small regular fluctuations can be split into components having periods of both a solar and lunar day, of the solar radiation (27 days) of a year, and of 11 year period of solar activity There might occur daily variation of a few minutes of arc in the declination Small changes of compass direction of the order of one-fifth of a degree daily in low latitudes also occur due to electric currents flowing in the ionosphere. In general the apparent daily variation follows the motion of the Sun

Besides the eleven-year variation-connected with on the Sun, there are also strong variations of one year and six months. These are associated with changes in the solar wind distortion of magnetosphere which results from the motion of the Earth 13.5 days are partly due to the spinning of the Sun on its own axis and partly due to the motion of the Moon around the Earth. These are

also variations of one day and 12 hours which are associated with the spinning of the Earth on its axis These are not the only variations, although they are stronger than the others The gaps between these are filled up with a host of other weaker variations, many of which have not yet been investigated and are only, partly understood For example, the variation associated with the rising and setting of the Moon

As the Sun rises in the east, the north end of the compass turns slightly in that direction. By noon, when the Sun is due in south, it is pointing in its normal position Shortly after noon, it begins wandering toward the west, following the Sun as it goes down By midnight, when the Sun is below the northern horizon, it is back to normal again This goes on day after day, month after month, but during the years when the sunspots are more numerous, the excursion of needle, on the average will be twice as great as they are when sunspots are lacking

The outside influence over Earth's magnetism lies in the upper layers of the Earth's atmosphere These upper layers being ionized by radiation from the Sun and other sources, become conductors of electricity As the ionized particles in the atmosphere circulate about the Earth's axis owing to Earth's diurnal rotation, the moving ions constitute an electric circulating about the axis of rotation. The various sources of ionization in terms of energy received are given below after AM skellett

Source of ionization--------Energy received by Earth/ergs/cm 3/sec.	
Ultraviolet light from the Sun	28 35
Meteors during meteoric showers upto	2 40
Ultra violet light from the stars	0.014
Cosmic rays	0.00031
Ultraviolet from the full Moon	0.00044
Meteor average normal daily AM	0.00024
Meteor average normal daily PM	0.00012

From the elementary laws of electricity a current travelling in a circular wire loop - induces a magnetic field within the loop The effective intensity of this field may be greatly augmented by the insertion of an iron bar perpendicular to the plane of the loop Thus the circulating electric current caused by the rotation of ions in the Earth's atmosphere will, by induction, tend to alter the magnetism in the iron core of the Earth, and every change in the electron density of the upper atmosphere will be accompanied by changes in intensity of the Earth's magnetism Solar disturbances, cosmic rays, and any other source of ionization of the Earth's atmosphere may, therefore, have their marks on the Earth's magnetic field

When a huge group of sunspots breaks out on the surface of the Sun, a stream of electrified particles reaching the Earth can so heavily ionize the upper layers of the air to interfere not only radio communication and reception, but to cause auroras If the aurora is an unusually bright one, these magnetic disturbances may be accompanied by heavy electrical currents induced in the Earth and in the wire and cable lines.

The Solar and Lunar Daily Variation

Besides the large and slowly appearing secular changes, there are smaller and more rapidly appearing changes during intervals as short as a day or less Of special interest is the change associated with the position of the Sun throughout the day, known as the solar daily magnetic variation, and a somewhat smaller similar effect associated with the position of the Moon, known as the lunar magnetic variation

It was found that the solar and lunar variations originate mainly above the Earth, with a minor portion, about one third originating within the Earth. The latter is ascribed to induce Earth currents It is fully established that upper winds produce the solar and lunar magnetic variations. These are partly a consequence of solar heating, and of tidal action These wind move

electrically conducting air across the lines of force of the geomagnetic field, thereby generating currents producing the daily variations

On successive days these variations are usually similar, since the phenomena shows regular and typical features, the variations depend mainly on local times, latitude and longitude The variations also show local features related to the Earth's main magnetic field There is also an important dependence on season related to the position of Sun It is because number of ions produced by the penetration of ultraviolet light varies from season to season and time to time For example, number of ions in winter are much lower than in summer, in winter the weakened sunlight fails to produce the large number of ions in the ionosphere that are found during the summer season when the Sun is high and days are long in the northern hemisphere.

The solar daily variation appear to be caused by two major electric current circulations flowing mainly in the sunlit portion of the upper atmosphere, clockwise in the southern hemisphere (as viewed from outside the atmosphere) and counter clockwise in the northern, moving of the Earth with the Sun so that their centres remain about -15^{o} longitude ahead of the noon meridian and at about -40^{o} of latitude from the equators On the dark side weaker and reversed vortices can be designated These current and circulations induce weaker current systems within the Earth which may contribute as much as 40% to the horizontal component of the solar daily variation at ground level In the northern hemisphere these currents produce an increase in the eastward component of the magnetic field (amounting to more than 50 gammas (1 gamma = 10^{-9} T = 1 nT, 1 gamma = 10^{-5} G(gauss)) in the forenoon in the middle latitudes and a decrease in the afternoon. The northward component increases to a maximum (of somewhat higher magnitude) just before noon at the equator, undergoes little change in middle latitudes and decreases to a minimum just before noon in high latitudes The vertical component

shows little change near the equator and in high latitudes but sinks to a minimum just before noon in middle latitudes

In summer the solar daily variation in the northern hemisphere is about 50% larger in amplitude than the yearly average, this condition repeated in the southern hemisphere about six month later At the equinoxes the amplitude is about the same in both northern and southern hemisphere These frequently appearing day to day differences may be as great as 100% in amplitude at any given station and as much as several hours in phase. This change in amplitude is mainly due to day to day changes in wind speed The amplitude also varies with sunspot cycle and may be as much as 60% greater at sunspot maximum than that at sunspot minimum. Moreover, there might occur seasonal variations in amplitude of the geomagnetic field. The increase in amplitude of variation with local season is due to improved electrical conductivity in the ionosphere as the apparent Sun moves northward or southward, and probably also in part to the response of the upper air winds

The solar daily variation also shows irregularities which depend upon regional anomalies of the Earth's main field. Because of induced currents, differences can probably be detected between effects noted over the oceans as compared with less highly electrically conducting land areas In addition there are effects related to the position of magnetic equator and to the general lack of symmetry of the magnetic field about the Earth's axis of rotation.

Lunar Daily Variation

We have, in space, the Sun emitting intense ultraviolet and X-rays, which strike the naked surface of the Moon as a target. The Moon, unlike the Earth, has no atmosphere to act as protecting screen from these penetrating rays from the Sun When these high energy solar rays strike directly the materials on the surface of the Moon, photoelectrons and possibly X-rays and gamma rays

are emitted When such radiations reach the Earth's upper atmosphere, they ionize the atmosphere similar to sunlight, although to a less degree The number of electrons liberated from the Moon in the direction of the Earth would depend upon the intensity of ultraviolet sunlight falling upon the Moon's surface and how much illuminated surface of the Moon is turned in the direction of the Earth at a given time. It has been noted that the ionization of the upper atmosphere of the Earth increases with the passing angle of elongation of the Moon from the Sun. As the Moon passes through the first quarter toward full Moon, a large area of surface exposed to the Sun sends more and more ionizing radiation toward the Earth The greatest percentage of the ionization has been recorded slightly after the full Moon i e 14.2 days (Stetson, 1947) These ionizing radiations from the Moon are responsible for geomagnetic variations with lunar phases

The lunar daily magnetic variation is also due to electric current circuits within the ionosphere These circuits migrate about the Earth with the apparent motion of the Moon, together with their induced current systems flowing within the Earth Instead of the four current circulations noted for the solar daily magnetic variation, eight are noted in the lunar case, of average strength about 1/20 that of the solar variations. However the strength of current flow in the current circuits for lunar variation is greatest on the sunlit side of the Earth

In addition to the daily variations geomagnetic phenomena include sudden commencements, bays, pulsations and solar flare effects on the geomagnetic field known as Crochets (*Encyclopedia Britannica*, 1969)

In spite of the above changes, as a first approximation, the components of the Earth's magnetic field can be regarded as produced by a strong short bar magnet, or dipole, at the centre of the Earth and pointing towards the "geomagnetic poles" of which the geographic coordinates have been found moving. In 1975, it was recorded

at 78 5°N, 69°-W and 78 5°S, 111°E However the above coordinate for epoch 1980 was calculated to be at 78 8°N, 70 9°W and 78 8°S, 109 1°E The strength of the dipole field at these poles is approximately 6×10^{-5} tesla (0 6 gauss) and on the geomagnetic equator i e the great circle half-way between them, 3×10^{-5}T (*Encyclopedia Britannica,* 1969)

Sunspot Cycle and Solar Radiation

The data indicate that Sun's brightness decreases by about one percent between the peak of the solar activity and its minimum The Sun grow more luminous as the number of sunspots grow larger The Sun's total light output, known as solar irradiance or solar constant has been found to vary by as much as 0 2 percent over the scales of weeks. There also occurs relatively short term variation, caused by passage of dark sunspots and bright faculae across the solar disk as the Sun executes its approximately monthly rotation

The hot outer layers of the Sun's atmosphere are responsible for the Sun's highly variable emissions of X-rays and extreme ultraviolet (EUV) radiations, the wave lengths between about 100 and 1000 Angstroms (1 Angstrom = 10^{-10} m) The chromosphere also emits a substantial fraction of the Sun's ultraviolet radiation at wavelengths between about 1600 and 32000 Angstroms, and probably accounts for most of the variability in these radiations. Solar X-rays have less impact on terrestrial life and EUV and UV emissions which are of concern because they significantly affect the Earth's atmosphere Measurements in the prominent hydrogen, emission line at 1216 Angstroms (The Lyman alpha line) indicate a variation in intensity of about a factor of two. The amplitude of 11 year solar cycle variation in the UV is elusive, because of calibration difficulties, but it has been found to range from as much as 20 percent around 1500 Angstroms to only 1 or 2 percent at wavelengths larger than 2500 Angstroms

The Sun's output of charged particles, which depend

primarily on conditions in the layers above the photosphere, also changes over the course of solar cycle The most important of these particles in terms of their impacts on terrestrial systems are the high energy protons that are occasionally spewed out by explosions in solar corona The Earth is also affected by more general outpouring of coronal plasma called the solar wind The high energy solar protons observed at Earth range from about 10 million to 10 billion electron volts (for comparison, a photon of visible light has an energy of about 2 eVs). These energetic protons travel nearly at the speed of light and arrive at Earth about eight minutes after the largest solar flares. The flares are huge eruptions in solar active regions, they cause these regions to grow dramatically brighter in X-rays and EUV. The frequency of solar flares is much higher near sunspot maxima than it is near minima

Variation in the continuous flow of solar wind plasma past the Earth near the sunspot maxima give rise to a different class of interaction The solar wind is excluded from the immediate vicinity of the Earth by the planet's magnetic field, which exert an electromagnetic force on charged particles attempting to cross Earth's field line; the volume around the Earth from which the bulk of solar wind is excluded is called magnetosphere Flares and other magnetic eruptions in the solar atmosphere lead to disruptions in the solar wind that alter the plasma pressure exerted on the magnetosphere. The observation made with ground based and space-craft instruments suggest that the cosmic ray intensity is lower during the years of high solar activity and sunspot numbers.

The primary cause of the solar modulation is the solar wind, a highly ionized gas (plasma) which boils off the solar corona and propagates radially from the Sun at a velocity of about 250 miles/sec. (400 km/sec). The wind is mostly hydrogen with typical density of 80 protons/inch^3 (5 protons/cm^3). This density is too low for collisions with cosmic rays to be important. Rather

the high conductivity of the medium traps part of the solar magnetic field and carries it outward

In addition to the bulk-sweeping action, another effect of great importance occurs in the solar wind, adiabatic deceleration Because the wind is blowing out, only those particles which happen to move upstream fast enough are able to reach Earth However, because of the expansion of the wind, particles interacting with it lose energy Thus the particles reach the Earth are of 10 MeV/nucleon energy. The solar protons with energy levels from 1 6x10^{-16} to 1 6x10^{-14} Joule (from 1 to 100 Kilo electron Volts) incident on Van Allen radiation belt during a magnetic storm create an equatorial current ring at a distance of 3 to 6 Earth radii from its centre. The magnetic field of the ring weakens the geomagnetic field in the main phase of the magnetic storm.

Solar Cycle and Radiation Belt of the Earth

The radiation belts undergo certain changes with time. The inner belt, which is closer to the Earth, has greater stability and undergoes insignificant variat-ions, whereas the outer belt experiences more frequent and pronounced changes. Small variations over the 11 year of cycle of solar activity characterize the inner radiation belt. The outer belt markedly changes its boundaries and structure when there are even slight perturbations of the magnetosphere. The low energy proton belt occupies an intermediate position

Especially strong variations of radiation belts are produced during magnetic storms Initially, the density of low energy particle flux increases sharply in the outer belt, and simultaneously a significant fraction of high energy particles is lost This is followed by the capture and acceleration of new particles, which cause particle fluxes to appear in the belt at distances closer to the Earth than they would under quiescent conditions. After the compression phase, the radiation belts slowly and gradually return to their original

state During the periods of high solar activity, magnetic storms occur frequently, causing the effects of individual storms to be superimposed on one another, the maximum of the outer belt is closer to the Earth during these periods (L~3 5) than during the periods of minimal solar activity (L~4 5 to 5)

The particle spray from the magnetic trap, especially in the zone of quasicapture of particles, leads to an increased ionization of the ionosphere, and an intense spray results in auroras The reserves of particles in the Earth's radiation belts is not sufficient to sustain a prolonged aurora, however, and the relation of auroras to variation in fluxes of particles in the radiation belts indicates only the general nature of this variations, in other words, it indicates that during magnetic storms particles are pumped into the radiation belts and sprayed into the Earth's atmosphere Auroras continue for the duration of these processes sometimes a day or more (Prokhorov, 1975)

Geomagnetic Perturbation and Sunspot Cycle

Fluctuation in solar activities accompanied by increase in number of sunspots and chromospheric flares alter the intensity of X-ray, ultraviolet and radio-frequency radiation and the corpuscular particles flux radiated by it. The increased level of ultraviolet light and the stream of electrified particles reaching the Earth can so heavily ionize the upper layers of the air to interfere not only with radio sky waves, but also to create sufficiently high electrical voltages as to cause visible discharges in the every rarified air causing it to glow like aurora Every auroral occurrence is accompanied by violent disturbances of Earth's magnetic field, shattering of radio-reception and communication If the aurora is an unusually bright one, these magnetic disturbances may be accompanied by heavy electrical currents induced in the Earth and in the wire and cable lines. Besides, these particles and rays also create magnetic storms on Earth that result into more severe

geomagnetic perturbations

A magnetic storm is one manifestation of the strong perturbations of the magnetosphere that occur upon the changes in the parameters of the solar wind, especially velocity of its particles and of the normal component of the interplanetary magnetic field with respect to the plane of the ecliptic Strong perturbations of the magnetosphere are accompanied by the appearance of the auroras, ionospheric perturbations and X-ray and Extra Low Frequency (ELF) radiations in the Earth's atmosphere (Shevnin, 1977).

The interplanetary magnetic field is primarily the field of solar wind (continuously expanding plasma of the solar corona) Near the Earth's orbit the interplanetary field is of the order of 10^{-4}-10^{-5} gauss The lines of the force of the interplanetary magnetic field have the shape of uncoiling spirals that emanate from the Sun (their shape is due to the addition of radial motion of the plasma and the Sun rotation) The magnetic field of the interplanetary plasma has a serial structure · in some sectors, it is directed toward the Sun, and in other, away from the Sun. The regularity of the interplanetary magnetic field is disrupted by solar flares (Aslamozov *et al.*, 1977).

Magnetic storms are caused by streams of solar plasma from active areas of the Sun that are superimposed on the calm solar wind. Therefore, they are more frequently observed near the maximums of the 11 year cycle of solar activity When they reach the Earth, the streams of solar plasma increase the compression of the magnetosphere, bringing about the initial phase of the magnetic storm, and partially penetrate the Earth's magnetosphere. The incidence of high energy particles in the Earth's upper atmosphere and their effect on the magnetosphere cause the generation and intensification of electric currents that attain great intensity in the polar areas of ionosphere, which is the reason for high latitude zone of magnetic activity. The changes in the magnetosphere-ionosphere current systems are manifested

on the Earth's surface in the form of irregular magnetic disturbances Magnetic intensity during the initial phase of storm, followed by much larger diminution to a minimum in about 24 hours occurs The recovery to normal values usually occurs in a day or two In the vertical intensity , the changes are small and reversed in sign in low and mid latitudes

The daily variation of the disturbance is associated with opposed current circulation In the northern hemisphere during storms an electrojet is directed westward, centred near an early morning hour meridian, near the auroral zone at 60°-70° north latitude Another electrojet is similarly centred in the south latitude Roughly diametrically opposite at the other side of the polar cap, a weaker eastward directed electrojet has been noted along the auroral zone. Electric currents circulate within the ionosphere completing their current circuits in low latitudes and across the polar caps.

Magnetic storms usually have preliminary, initial and main phases During the preliminary phase, slight changes in geomagnetic field are observed (mainly in the high latitudes) and typical short periodic fluctuations of the field are excited. The initial phase is characterized by a sudden change in individual components of the field over the entire Earth; the main phase, by large fluctuations in the field and a strong decrease in the horizontal component In the restoration phase of a magnetic storm, the field returns to its normal values In a disturbed geomagnetic field, a distinction is usually made between a periodic variations, polar magnetic sub-storms (which appear in the middle latitudes in the form of coil-shaped disturbance) and specific short period oscillations.

Magnetic Storms

The magnetic storms often start suddenly over the entire Earth soon after the onset of active solar changes, such as those related to actively changing sunspots. They are more frequent and intense around or somewhat after the

maximum of each sunspot cycle, and less frequent at sunspot minimum Magnetic storms last several hours to several days. These also tend to recur every 27 days, a consequence of solar radiation period Some sequences have persisted for as many as 17 solar rotations Magnetic disturbance is more marked at the equinoxes, the value being about 30% higher than at the solstices (*Encyclopedia Britannica,* 1969) As compared to periodic daily solar and lunar variations with amplitude of 30–300 gammas and 1–5 gammas respectively at the low and the middle latitudes during the quiet periods, fluctuations of geomagnetic field caused by magnetic storms occurs in a broad range of frequencies (from 10^{-5} to 10^{2} Hertz) and amplitudes (from 10^{-3} to 10^{-7} Orested) in the near terrestrial space and on the Earth's surface. They are manifested with greatest intensity (up to about $5x10^{-2}$ Orested) in the high latitudes In the middle latitudes changes in the intensity of the geomagnetic field during the magnetic storms ranges from 0.1 to about 1 ampere per meter (A/M) or about $1x10^{-3}$ – $1x10^{-2}$ Orested A storm may discharge energy at a rate of more than 10^{9} horsepower for a period of one to several hours. This field changes at the rate of 10 to 20 gammas per second.

Though magnetic field changes minute by minute, during magnetic storms the field changes with time are particularly irregular, complex and erratic and give rise to an apparent diurnal effect. The daily variation varies in amplitude with storm time, more or less in unison with the average storm time variation. The average storm demonstrates an increase in horizontal component

As indicated, the outside influence over Earth's magnetism lies in the upper layers of Earth's atmosphere. As the ionized particles in the atmosphere circulate about the Earth's axis, owing the Earth's diurnal rotation, the moving ions constitute an electric circulating about the axis of rotation. Thus circulating current, by induction, tend to alter the magnetic field

of the Earth The resulting fluctuations in geomagnetic fields are typically only 0 1 percent of its roughly one gauss intensity But the electric current they can induce in large scale conductors at the Earth's surface, such as powerline networks and oil-pipelines can have dramatic effects (Foukal, 1990) The increased ionization of ionosphere causes twice as great as usual solar and lunar daily variations (Stetson, 1947)

Investigations through sounding rockets and satellites have established the fact that in addition to pronounced diurnal variation in the upper atmospheric density, reaching a maximum about two hours after local noon and a minimum between midnight and dawn, large fluctuation occur with solar activity These variations with solar activity include erratic or 27 days variations with solar activity, semi-annual or annual variations and geomagnetic perturbations, superimposed on 11 year solar cycle variation in the upper atmosphere

In some regions of the Sun, the open field line configuration allows charged particles in the solar wind to escape quite easily This results in areas of depleted corona plasma or "Coronal holes" Holes are always present near the solar poles, but they can also evolve at lower latitudes. Low-latitude holes produce high velocity solar wind streams that can spray the Earth directly and recurrently as the Sun rotates The appearance of holes is linked to the solar cycle, but with a different sort of modulation than is observed for sunspots. Although the data are limited, it appears that the largest low latitude holes develop during the declining phase of a cycle, so that their contribution to geomagnetic activity is greatest, a few years after the peak sunspot numbers (Foukal, 1990)

It has been reported that radiowaves from the Sun are at a frequency of 2,00,000 kilocycles and there is a close relationship between the strength of these waves and the number of sunspots (Pawsey *et al.*, 1946). Moreover the sunspot maxima accompanies the preponderance of ELF (extra low frequency waves).

Sunspot Cycle and Terrestrial Phenomena

As a result of altered solar radiations, the Earth and its environments are variously affected. Satellite measurement reveal that solar constant varies by as much as 0 2 percent over time scales of weeks The Sun being brightest during the sunspot maxima which results into higher temperatures The climate models suggest that the size of the effect is well below 0 1 Kelvin The current models of ozone production indicate that these changes in solar UV emission might cause a variation from 1 to 2 percent in total global ozone There is a good evidence that the thickness of ozone layer varies with sunspot, hence the amount of ultraviolet light filtering through this ozone layer arriving at Earth's surface is much higher at sunspot maxima than it is at minima (Foukal, 1990)

Sunspot Cycle Heliobiological Effect

The cyclic fluctuations in solar radiation affect the life processes of the terrestrial organisms. These effects are mainly caused by increased ultraviolet UV-B and UV-C radiation and ELF and RF reaching the Earth. Moreover, the biological systems may also be affected by increased positive ion concentration and depletion of negative ions in the Earth's environment It is because of the fact that the negative ions have a tendency to attach themselves to clouds and do not reach the biosphere (Tompkins, 1978) It is believed that the geomagnetic field, as well as changes in it, plays an important role in the orientation of animals in space and time. Along with other physical factors, it may have an orienting effect in the long distance migrations of birds and fish and in the movements of insects, worms, mollusks and other animals. Certain plants orient their root systems relative to the magnetic meridian. Fluctuations in geomagnetic field induced by changes in solar activity also affect many processes in the biosphere. As discussed in the preceding chapter, prolonged artificial attenuation of the geomagnetic field by screening or

compensation has shown an unfavourable effect on the vital activities of animals, plants and microorganisms

Similarly, the exposure to radio and extra low frequency electromagnetic radiation leads to a variety of changes in the biosystems Large proton events are of concern to commercial air lines, particularly when flying along the polar routes, where the Earth's magnetic field lines curve down to the surface and allow charged particles to penetrate to low latitudes, exposing passengers to elevated levels of radiation These events pose a more serious threat to astronauts These events have also been implicated in the failures of computer systems In the following chapter the effects of sunspot cycle on stratosphere and biosphere have been dealt with in detail while indicating the possible bio-interaction mechanisms due to altered solar radiations

CHAPTER 7

SOLAR CYCLE AND HELIOBIOLOGICAL EFFECTS

It deserves mention that our life, health and behaviour depend upon cosmic factors beyond our control. From cosmic point of view, life exists as a tiny organism in a microscopic film at the surface of the small planet on which we live. It exists only because the amount and quality of the light and heat radiated from the Sun. It continues only so long as the temperature to which it is subject is maintained through a relatively small range of variations Life is subject to gravitational and electromagnetic forces concerning much of our environment We know that each unit cell is composed of molecules and atoms, which in turn are bundles of electrical energy. Modern medical science has made us aware of the electrical nature of cells. What subtle effects changes in our environmental fields may have on life in any form, we do not know exactly. The geomagnetic fields, Schumann bands of ELF radiation (1-30Hz), originating from the resonances in the insulating cavity bounded by the conducting Earth and the conducting ionosphere, and other phenomena depicted in fig. 16 combine to form man's natural electromagnetic environment.

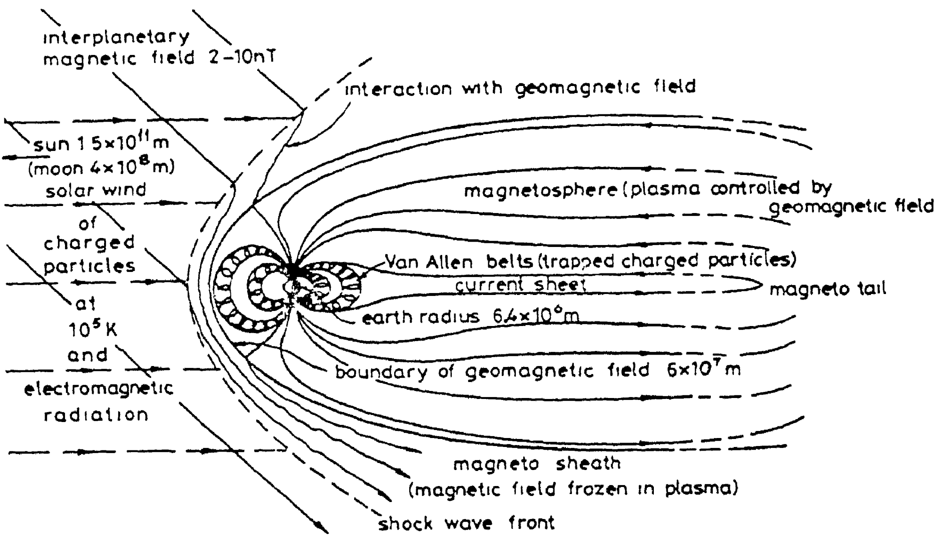


Fig. 16. The Earth's Electromagnetic Environment *Our Earth is in the outer atmosphere of the Sun. This figure shows all the particles and electromagnetic fields which buffet us, protect us, and couple us to the tides and fields of the planetary system.*

We know that every living cell survives in an electrical field which extends from the surface of the Earth upward. It is the field that gives rise to the electrical potential in the atmosphere that under ordinary fair weather conditions amounts to about 100V/M near the ground (Stetson, 1947, Smith and Best, 1989 Fig. 17).

Where long records of the potential gradients of the air-Earth field has been carried on extensively, there is some evidence that this potential gradient varies with sunspot cycle, because of increased level of ionization Moreover, some similar changes have also been found associated with lunar phases that affect the potential of living beings (Burr, 1944) If the

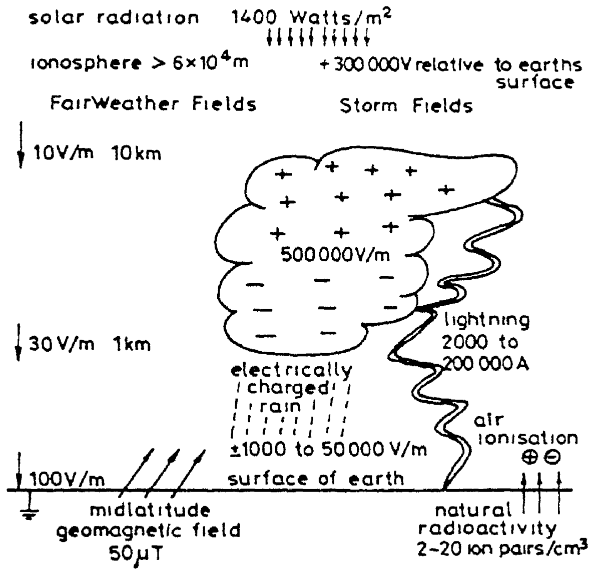


Fig. 17. Man's Natural Electromagnetic Environment *We are warmed by the Sun, watered by the rain, and exposed to the electromagnetic fields generated by our weather systems. The thunderstorms keep us in touch with the state of the ionosphere by stimulating the Schumann resonances which are close in frequency to our brain-waves. Ions, blown through the magnetic field of the Earth are deflected and set up electric fields. Natural radioactivity from the core of the Earth, cosmic radiation and breaking water droplets, give the air an electric charge of ions* (After Smith and Best, 1989)

electrical fields of living cells can be influenced by the electrical field of the nature in which they must develop (Burr and Northrop, 1939), there may be more truth than fancy in the hypothesis that cosmic cycles govern the biological behaviour.

Specific behaviour in a geomagnetic field was observed not only in microorganisms but also in some plants, and the effects known as Magnetotropism (Kirlov and Tarakanova, 1960). Magnetotropism manifests itself

in the orientation of seeds, roots and germinates towards power lines of geomagnetic fields Plants react very effectively to a constant magnetic field when its direction coincides with the direction of geomagnetic field (GMF) Pittman (1962) and Novitzkii (1978), reported different orientational properties to the GMF and this connected with the different sensitivity to the acting magnetic field

By studying fossilized remains of organism, it was found that certain species that had existed for millions of years, became extinct over relatively short periods of time Some of the scientists working in this field showed that these extinctions seem to closely related with reversals of the Earth's field, and as a result they suggested that these organism actually used the field for some purpose The reason for effect was attributed to toxic levels of oxygen in water (Jacob, 1984)

Dr Robin Baker, from Manchester University, has tested the ability of humans to find north using the Earth's field, and he was able to show that, on average, most people were able to do this to some extents, but some people were better at it than others It has been suggested, on numerous occasions that human dowsers are able to find underground water because the flow of such water causes fluctuations in the magnetic field of Earth. There have been some scientific experiments which show that dowsers may well be using the magnetism of the Earth and its changes to achieve their results (Seymour, 1988)

In a series of experiments Kholodov subjected pregnant rats to artificial magnetic field similar in strength the behaviour of the Earth's field during a geomagnetic storm The offspring of such rats were less active than normal offspring and they committed more errors in the laboratory When Kholodov subjected the pregnant rats to fields 100 times stronger than that of the Earth they produced distinctly fewer foetuses than normal, there was an increase in the number of still

births and some of the offspring were born with ruptures of spinal column In another series of experiments Kholodov showed that the brains of vertebrates, which had been surgically separated from the sense organs and other parts of the nervous system, responded more positively to magnetic fields From this he concluded that the sense organs prevent the brain from reacting fully to the magnetic field Other experiments on humans show that our reaction times, our ability to adapt to seeing in the dark, and our ability to distinguish a very rapidly fluctuating light source from a continuous ones, were all affected if we were shielded from the geomagnetic field (Dubrov, 1978; Barthnothy, 1965 & 1969)

An Australian scientist, Birzele, collected yet another set of evidence of the effect of geomagnetic field from investigations on the state of the magnetic field within one or two days of birth, Birzele found that the similarity between personality characteristics of the child and one of its parents was linked to the similarity of geomagnetic activity close to the both of the child and the particular parent These results suggest that geomagnetic activity can enhance the genetic inheritance of certain personality characteristics

The present chapter deals with heliobiological effects of sunspot cycle and . lunar phases As discussed in the previous chapter, there occurs major changes in amount and quality of the solar radiation between the two extremes of the 11-year sunspot cycle. The activities associated the sunspot cycle often affect the life on Earth and its environments These are due in large part to the many electrically charged high speed particles and also ultraviolet, ELF and X-rays emitted from the Sun during the sunspot maxima. The biological systems are affected indirectly through environmental fluctuations and directly through radiant energy, such as ultraviolet light, ELF, induced electrical currents, geomagnetic perturbations etc. It has been established that following the 11-year solar cycle fluctuations in

Earth's magnetic field and appearances of northern lights or Aurora Borealis, occur closely parallel the number of sunspots on the Sun Relationships have been found linking sunspot numbers and the level of *Lake Victoria*, the depths of the *Nile*, the *Thames*, and the *Elbe*, monsoon's in India, rainfall in Mauritius and Australia, soil temperatures in Scotland, and many other indices of local weather around the globe (Eddy, 1978). Stetson (1947) mentions that North Atlantic Ocean, South America, Africa, India, Australia show 10 to 20 percent more rainfall during sunspot maxima than during sunspot minima

Sunspots and the Weather

The radiations and particles emitted by sunspots have their effects on the Earth The beautiful spectacular display known as Aurora Borealis (the northern lights) is produced by charged particle from the Sun, as are disturbances to high frequency radio There is also some evidence suggesting that the weather is affected by sunspots, with such things as temperature, rainfall and barometric pressure fluctuating with the sunspot cycle over the years The magnetic fields on the surface of the Sun are known to reverse their magnetic polarity in the period of 22 years, or two sunspot cycle This reversal of polarity is reported to cause droughts accompanying "dust bowl" on Earth and the 11-year cycle with less severe droughts. However, the correlations seem to be rather insufficient, and the research in this area is largely insufficient (Pittock, 1978)

The studies of Garcia-Mata and Schaffner (1934) show that American production as a whole was affected by the sunspot cycle A relationship between high temperature and high frequency of sunspots has already been established by King (1973). Using estimates of the average annual temperature in England, Huges (1977) has demonstrated that this relationship is valid at least for the period of the 'Maunder Minimum', which is also known as the "Little ice age". There are other evidences linking

sunspots with temperature One such line of evidence can be traced through the study of tree rings, which grow faster in warm, wet weather The width of tree rings tends to vary the world over, as whole The sunspot cycle can be seen charted in the wide rings that occur after every eleven year or so Research has shown that it is rainfall as much as warmth that is responsible for the width of rings, with narrow rings clearly associated with droughts (Cook and Jacoby, 1977)

Barometric pressure is more puzzling However, there are some results from Russia and Indo-Malaya, which exhibit barometric pressure varying with sunspot activity increasing at times of maximum sunspot in Russia and decreasing in Malaya

The Weather and Man

The weather conditions caused by sunspots, in turn, exert their influence on the lives and emotions of man It has been known since early eighteenth century that the number of patients admitted to mental hospitals tends to increase in summer This spurt seemingly comes from a peak in the psychotic disorders of schizophrenia and manic depression There also appears to be a peak in suicide rates in spring, with a smaller peak in the autumn and a peak in depression following child-birth. The studies of Cunningham (1979) show that the behaviour of man varies with the rise and fall of temperature (with sunshine) and becomes more helpful and generous under clear sunshine On the effect of certain winds, some interesting researches have been done In various parts of the world there are days in which a hot dry wind blows and everywhere the effect on the people is said to be much the same It has been noted to produce lassitude, depression, irritability, insomnia and even nausea, and can trigger off attacks of migraine and asthma and lead to an increase in suicides and road accidents (Moos, 1964, Rim, 1975,1977). The study of Rim suggests that all this occurs due to the lack of the negative ions in the atmosphere.

Subjects studied in the environment of positive ions, that tend to increase at sunspot maxima due to attachment of negative ions with clouds, reported giddiness, headache, discomfort, etc Such data tie in with the theories of Wilhelm Reich about the healthful effects of negative ions, what he calls "Orgone energy" and the toxic effects of its counterpart or deadly Orgone" which was reported to turn rocks brown, make strong men giddy and bring on women's menses out of season Thus, these studies illustrate the possibility that weather can have real psychological effects and that ionic imbalance may be one of the casual links Whether the ions in turn are affected by cosmic influences such as radiation or charged particles reaching the Earth's atmosphere, is something that must be a clear example of a cosmobiological effect

Sunspots and the Human Mind

About five decades ago, two scholars B and T Dull, claimed to have found links between various phenomena, such as sunspots, magnetic storms and the Northern lights, on the one hand, and human fate, such as deaths from diseases and suicide on the other. They reported an increase in suicide of about eight percent on days of marked sunspots activity The same has also been true of other claims that suicides and admissions to psychiatric wards increase on days of high magnetic disturbance or cosmic ray activity (Pokorny & Mefferd, 1966) Some scholars have also reported a link between electromagnetic disturbances and accident proneness (Tromp, 1963; Lynn, 1971)

Sunspots and Health

Electromagnetic storms during the peaks of the sunspots have been reported to cause the death of patients from heart attack (Tocquel,1951, Malin and Srivastava, 1979) But the above results may not be taken to be a universal phenomenon, since the studies of Lipa *et al.* (1976) in the U.S A and Knox *et al.* (1979) in the U K negate the

observation of the above scholars Reason is not known why their data are so different from those found in India It has been observed that there is an increased tendency for the blood to clot at times of sunspot activity (Eysenck and Nias, 1982), that could obviously provide a link with strokes and heart attacks

There have been various attempts to find a connection between sunspot and illness Of these, the connection between sunspots and tuberculosis,skin cancer (Melanoma) (Houghton *et al* , 1978), caused by exposure to ultra-violet rays (the level of which reported to be higher at sunspots maxima) Cholera, Diphtheria, Typhus, Plague, epidemics (Chizhavsky, 1934) have been fairly well established It has also been observed that sunspot maxima tend to create mass excitement, such as revolutions and mass migrations (Eysenck & Nias, 1982) This may explain why people voluntarily, without any propaganda or invitation, congregate on at the *Kumbha Mela* sites.

Sunspots and Chemical Reactions

If the Sun or any of the other heavenly bodies have an influence on human life, there must be mechanism by which they can do so Some transfer of matter or energy takes place, and on the basis of present state of knowledge, it may be assumed that this energy is in the form of electromagnetic radiation. The known forms of radiant electromagnetic energy vary from low frequency radio waves, through the spectrum of visible light, to X-rays and beyond Besides these, there may be some other forms of radiant energy, as yet not known to science, but perceived by *Yogis*

It may be particularly interesting, therefore, to come across experiments which appear to demonstrate the effect of extraterrestrial radiation on chemical processes of the kind that occur inside our bodies. For example, there are evidences showing aberrations in the freezing point of water as a result of some outside radiation. Experiments conducted on colloids point in the same direction Colloids are especially interesting

because they are particularly susceptible to electrical effects and also because they take part in many of the processes within the human body Findeisen (1943) reported that even when kept in sealed vials under constant conditions, certain non-random fluctuations in the behaviour of colloids take place Piccardi (1962) believes that ELF (Extra Low Frequency) waves could be responsible for these fluctuations He also observes that, as well as varying with sunspot activity, the reactions vary with the time of the year, and he thinks this is because its orientation towards the galactic radiations and particles that are constantly streaming through the solar system

If the Sun can have this effect on the interaction between water and a colloid, it is possible that it could have a similar effect on living creatures, including human beings. After all, human body consists of 65% water and most life process are based on organic colloids Some research does indeed suggest that the Sun affects living beings in this way The experiments of Gauquelin suggest that microbes reproduce more rapidly with changes in weather This he does not attribute to the effects of temperature and barometric pressure but to some sort of cosmic radiation A direct effect of radiation on the human body was demonstrated by a Japanese hematologist-Maki Takata (1951) His experiment shows that the level of blood albumen, which helps the blood to clot, increases under sunspot maxima and decreases under shield or solar eclipse There is no effect of X-ray or gamma rays, and only solar radiation has a dramatic effect. This has been correlated with ELF waves, known to increase during heightened sunspot activity.

If the increased incidence of heart attacks and strokes at times of peak sunspot activity is eventually confirmed, Takata's findings may provide a viable explanation. It may be correlated with the Piccardi's inorganic and that of the Caroli & Pichotka (1954), colloidal reactions which exhibit that both organic and

inorganic reactions vary together (three and half times higher) In this connection, the study of Schultz (1960) relating solar activity to types of white blood cells deserves special attention His study demonstrates a tremendous increase in one type of white cells, other components of the blood were found to decrease in particular, the incidence of leukoponia (which comes from the deficiency of another form of white blood cells, more than double ranging from 13 to 29 percent following a violent-solar eruption (at the time of highest sunspots)

Similarly, the impact of solar energy refracted or reflected by the Moon has not been studied scientifically. However, it has been found that the lunar phases do affect the psychological behaviour of creatures - the net effect differing with the latitudinal variation on the Earth Since the main bath of the *Kumbha Mela* occur on either new or full Moon days, it is pertinent to examine the effects of lunar phases The experiments of Bradley, *et al.* (1962) show that the pattern of the rain and shine follows the rhythm of the Moon They found the heaviest rainfalls a few days after both the full and the new Moon. A possible explanation for this effect is that the Moon may act to deflect the 'Solar wind', which causes changes in the upper atmosphere, and also to shield the Earth from some of the meteoric dust around which water droplets may condense to form raindrops Lunar rhythms also have been found showing voltage difference in plants and man (Burr, 1972, Ravitz, 1962) Murder, lunacy and crimes have been found to be influenced by the Moon, culminating particularly on the new and full Moon days (Lieber and Sherin, 1972, Lieber, 1978) Further, the studies of Tasso and Miller (1976), Jones and Jones (1977) and Garth and Lester (1978) indicate that cases of murder, rape and suicide are linked with the full and the new Moon. The full Moon has also been associated with mental breakdown (Campbell and Beets, (1978), Cooke and Coles (1978) etc). In several experiments, it has been fairly well established that Moon influences blood flow. Andrews (1960) records

maximum operative bleeding around full Moon periods Rhyne (1966) made the observation that 90 percent nose-bleed ailments were found in persons whose Moon signs were either in Capricorn, Aquarius or Pisces

Cause and Effect Mechanism

Man, like all life on Earth, has evolved in an environment flooded with electromagnetic radiation of most wavelengths and varying degrees of coherence The living systems emit vary coherent radiation, albeit at very low intensities, high up to the ultraviolet part of the spectrum (Smith *et al.*, 1986, Popp, *et al* , 1988) From the evidence now available, it seems that living systems are able to make use of whole of the electromagnetic spectrum for communication and control activities from the ultraviolet to sub-Hertz, and with sensitivities limited only by law of physics (Popp *et al.,* 1988) The oscillations must be highly coherent in both space and in time The maximum degree of coherence in time which can be of significance is that corresponding to the life-time of the organism itself, for this the bandwidth of the frequency spectrum will be of the order of the reciprocal of the life time The degree of spatial coherence must be at least that corresponding to an organism's spatial dimension, but man's coherence may well extend outward in space and time to encompass the total sphere of his influence through the spiritual dimensions. The altered solar radiation at each sunspot cycle could disturb the spatiotemporal coherence of energy with which the biosystems may react as mentioned below.

Biological Effects of UV-Radiation

The solar UV radiations can be conveniently divided into three categorises: UV-A (wavelength 320-400 nanometer), UV-B (280-320 nanometer) and UV-C (shorter than 280 nanometer) All of these are mostly absorbed in the stratosphere. Of these, only UV-A reaches the Earth, under the beneficial effects of which most biological

systems evolved During sunspot maxima, UV-B (290 nanometer) also penetrates the atmosphere of the Earth (Rowland, 1978)

It has been recognized that ultraviolet light plays an important part in creation of vitamin D in plants and animals A deficiency of vitamin D leads to rickets Experimentally, it has been noted that its different dozes and bands affect both plants and animals variously The over exposure to UV-B often results in premature ageing of the skin and increases the risk of skin cancer and sunburns The risk of skin cancer is noted to be significantly greater for people living in low latitudes than for those in high latitudes This band of UV is experimentally found to inhibit plant growth (Rowland. 1978) There is some accumulating evidence that secretion of our endocrine glands, so essential to our well being, are affected by varying amounts of ultraviolet radiation Some plants are very sensitive to light of very short wavelengths Plants exposed in undue ultraviolet light shrivel and die Moreover, there is evidence that medicinal properties of plants are also affected by ultraviolet light. It has been recorded that Alfalfa grown in Arizona and cured in bright sunlight developed anti-rachitic power, which could not be found in the same plant cured in darkness (Stetson, 1947). Several other Bio-effects of UV-Radiations are as follows .

Ionization and excitation of atoms and molecules in biological material result in the observed damage, however, the precise mechanism by which radiation produce their biological effects are not understood. It is clear that some of the observed effects occur as a result of direct interaction of an ionized particle with vulnerable cell constituents, perhaps enzyme systems It is also clear that the observed effects result, at least, in part, indirectly through interaction of particles with water, with the production of "hot" radicals such as OH, H, H_2O_2 and HO_2 (Hollaender, 1954).

Cellular Effect

At cellular level observed effects such as delayed cell division, cell death, etc, appear to result principally from damage to the cell nucleus A temporary inhibition of cell growth and division may occur, or growth may continue without division with the formation of large multinucleated cells Cell deaths result from failure to divide, and at some doses through direct injury Although actual process of DNA synthesis is relatively insensitive to radiation, the apparent sensitivity, however, in some instances may result into mitotic inhibition or cell death and loss (Lea, 1947)

In multicellular systems, different cells and tissues differ widely in their sensitivity to radiation In general, more rapidly proliferating tissues, such as, the haemato-poietic and lymphoid tissues, and gastro-intestinal epithelium of mammals, are most vulnerable The apparent difference in "sensitivity" of proliferating organs result in part from a cell death and thus organs depletion, and in part from partial, or essentially complete stoppage of new cell production and depletion of tissue cells through normal cell death and removal If regeneration is not sufficiently early and rapid, the cellularity of organ may reach low level incompatible with life of organism As an example, at high doses the epithelium of small bowel continues to disappear thereby resulting into illness and death of the organism similarly with the red cell production (Patt & Powers, 1956) The above described process of cell death and loss in proliferating tissues of the mammal is chiefly responsible for "acute total body radiation syndrome" seen in mammals and man Doses up to the order of 200 rad in intact mammal result in no marked visible change, and only temporary changes in the numbers of cells in the bone marrow blood, and lymphoid tissues. At higher doses, marrow depletion and the resulting disappearance of white cells and platelets in the circulating blood, lead to extensive haemorrhage and infection. Haemorrhage results principally from lack of

platelets, necessary to maintain haemostasis Infection results from the lowered or zero white blood count, and in part from failure of the antibody-producing, and other immune protective systems following large exposure This symptom complex is known as "bone marrow syndrome" Further, at higher doses (≥1000 rads) rapid depletion of cells of gastro-intestinal tract leads to death from fluid and electrolyte imbalance and shock in few days (the gastro-intestinal syndrome) At still higher doses, death may result in a matter of hours from changes in the central nervous system

Cataracts are a common finding, leukemia and other forms of neoplasia also result It appears definite that life span is shortened.

Ionizing radiation have also been found to produce essentially all types of cancer In spite of several attempts, the mechanism of cancer induction is not known. Some investigators have favoured the somatic "mutation theory", attractive because of the known genetic effects of radiation Many radiation induced cancers are found to be hormonal dependent Including this, several other considerations lead many investigators to feel that biochemical imbalance in the host resulting from generalized radiation damage may be a more important factor in tumour induction than direct effects of radiation on the involved cell

Gene mutations resulting in genetic effects may represent the most sensitive biological response to radiation. The relationhsip between mutations and dose is linear, leading to conclusion that genetic effects can result from a single ionizing even within a gene. Such changes may occur in somatic, as well as reproductive cells (Homburger and Fishman, 1952).

Molecular Changes Induced by Absorption of UV-Radiatio..

The ultraviolet absorption changes the electronic configurations of molecules. The electronically excited molecules may dissociate directly into atoms or radicles

if sufficient vibrational energy is accumulated on one chemical bond, and the same result may occur indirectly by the change of primary excited state to one of the lesser stability (predissociation) Transfer of excitation energy intermolecularly or within a macromolecule, by collisions, or by classical resonance could play a bio-significant role For example, carbon monoxide (CO) may be dissociated from CO myoglobin complex with a quantum yield of about unity, by irradiation at 280 nm (absorbed by protein) or at 560 nm (absorbed by haemin groups), and the reaction produced by 280 nm radiation probably is due to energy transfer from the aromatic groups of the protein to the haemin-CO moiety Photochemical transfer of electrons or protons has also been demonstrated, and has been postulated as of biological importance The presence of radicals produced from oxygen and water by direct UV-absorption (below 190 nm) or by energy transfer can modify the primary photochemical steps in solute molecules and produce changes similar to those of high energy radiation, as in decomposition of the macromolecule, DNA

Germicidal Effects

The bactericidal action spectrum of UV-radiation with its maximum at 260-265 nm is almost certainly due to direct action of the radiation on some biological macromolecule, probably one or both of the nucleic acids The experimental survival curve obtained on irradiating bacteria supports the hypothesis that a single quantum is sufficient to kill A minor part of bactericidal mechanism can be indirect, probably through the medium of photochemically produced peroxides Experiments show that the incident energy (253.7 nm) can inhibit colony formation in 90 percent of organism

Virus can be also affected within or outside its host by UV radiation. A direct effect has been noted, with an action spectrum around 260 nm, which varies in definition for different viruses, probably due to the exact type of nucleprotein complex involved, to its

recombination with other macromolecules, or to screening materials For most but not all viruses, a one-quantum hit curve is reported The quantum yields for virus inactivation studied so far are low eg about 10^{-4} for bacteriophage (T2 type, 254 nm), a much lower value for nucleic acid constituents (about 0 01–0 1), possibly due to these molecules protective combination in a macromolecular complex in the virus particle

Apart from inactivation of viruses, which results from suppression of any one of the steps necessary for successfull infection, a number of non-lethal effects of radiation has been observed, some transmitted to the progency and some non-hereditary For exaple. exposure of influenza virus to UV-radiation for progressively longer periods eliminates one after another, all the properties of virus, ranging from its reproductive abilities to its haemglutinizatino property and complement fixing antigen Experiments with fungi lead to many similar conclusions, eg the presence of direct or indirect (probably peroxide) effects, an action spectrum for direct effect at about 260 nm for killing and for nearly all mutations, and evidence for the large role of the nucleus with possible participation by cytoplasm in these events

Effects in higher Organism

Studies of protozoa and invertebrate eggs emphasize the role of extranuclear material in ultraviolet radiation effects For some of these organisms, the maximum change (immobilization, vesiculation, or prevention of hatching) occurs around 280 nm, suggesting action on the cytoplasmic or shell proteins, while activation of sea urchin egg is produced sharply at 240 nm and below as if non-aromatic protein or lipid material (eg in the egg membrane) may be affected primarily In other organisms, maximum killing results at 257 μm

In general, studies of the genetic and cytological effects of UV-radiation are limited by the techniques available for irradiating germ cells without causing

physiological damage or killing the cells The fruit-fly and maize and other plant pollen cells are convenient and extensively investigated objects of study Comparison with the effects of X-irradiation reveals interesting differences, eg , in the production of mutation and of chromosome breaks Combination of two types of radiation in Tradescantia results in chromosome effects which apparently differ in nature and origin Similarly, in maize, the X-ray effects (on frequency of germless seeds) is inhibited by post-treatment with 297 nm radiation, but the UV-effect is uninfluenced by X-radiation It is suggested that UV-radiation affects the matrix of the chromosomes, causing coagulation which could present chromosome rearrangement after the X-ray breaks ESR studies of Kirby-Smith and Randolph (1960) show that protein gives a far higher resonance signal than does DNA when X-ray are used, while the opposite situation occurs with ultraviolet radiation

Mutational Effects

For mutational and chromosomal effects, the action spectrum parallels the absorption curve for DNA or its precursors Wavelengths shorter than 250 nm and those around 280 nm and longer are heavily absorbed in both the cytoplasmic and nuclear proteins and, consequently, affect processes (eg spindle formation and cell division) which depend upon protein synthesis and aggregation consummation of the mutation and inactivation event is not dependent upon absorption alone, however, time is required, and at least a portion of events is reversible by visible light through the mechanism of photoreactivation.

Two additional pieces of information relating to the effects of UV radiation are worthy to mention The first is that the lambda phage in E.coli, strain K-12, can be converted, with an efficiency approaching 100% from a lysogene to a lytic state.

The second study relates to the combined effects of UV and X-ray on induction of chromosomal aberrations.

Swanson (1944) mentions that UV has a profound effect in preventing the formation of X-ray induced aberrations either when employed as a pretreatment or when given within the space of an hour after X-radiation Kirby-Smith and Necoletti have demonstrated that light of wave lengths 265 and 280 4 nm has a synergistic rather than an inhibiting effect when combined with X-ray (Swanson, 1960)

Photoreactivation

When the effects of ultraviolet irradiation are modified or counteracted by exposure to longer wavelength UV or visible radiation (usually at wavelengths around 330-480 nm) the phenomena is known as photoreactivation (or photorestoration or reversal) Such changes that can be detected even when the second exposure occurs some hours later, were noticed for the first time in micro-organisms but are known now to be much more general Of various absorbers, porphyrins has been suggested to be one suh example The possibility of the occurrence of weak but significant long wavelength absorption in a number of naturally occurring molecules, due to triplet state excitation, may be considered in this connection, but reversal of some low energy chemical processes such as cis-trans isomerism or release of loosely held electron has been a suggested mechanism of photo-reactivation

Alternatively, an indirect effect may operate, such as the production of a substance which allows some consequence of ultraviolet damage to be circumvented. Total UV damage under given condition of temperature, nutrition, etc. may be due to changes at a number of different sites in the cell, in bacteria, zero point mutations can be suppressed but not delayed ones Further, temperature affects photoreactivation, showing that dark reactions are involved Thus, it may be indicted that semistable intermediate states (of genic material or of extragenic chemicals) exists between the

absorption of UV radiation and the final biological effects

Carcinogenesis

The suggestion that light causes cancer of human skin arose (1894 and later) from observations of higher skin tumours incidence (i) on exposed part of the body, (ii) among outdoor than among sedentary workers, (iii) in fair complexioned than in dark-complexioned people, and (iv) in regions of Earth which receive greater insolation Later studies of laboratory animals, particularly of mice and rats using filtered sunlight showed that UV radiation below about 310 nm is carcinogenic agent The type of tumour produced, i e , carcinomas (in the epidermal layers) or sarcomas (originating in underlying tissues) depend upon spectral transmission of the skin, which is greater in mouse than in the human Repeated doses are necessary for carcinogenesis, as in an investigation using albino mice, tumours appeared earlier after irradiation with wavelengths 280-310 nm than with 254 nm radiation, and while carcinomas were found in both groups, only in former were sarcomas produced These results are explicable in terms of increasing penetration of skin with wavelengths of radiation.

Erythema

The UV irradiation produces erythema (skin reddening etc) in 250 nm and 297 nm regions The minimum effect at 280 nm is due probably to low transmission (maximum screening) at this wavelength by the proteins in the superficial skin layer, and there is evidence that the two active wavelength regions are responsible for two different photochemical reactions - one (at 250 nm) in superficial cells, and the other (at 297 nm) in deeper, mucous layers - leading to erythermal reactions with different physical characteristics.

Pigmentation of skin, which follows subsidence of erythema, comprises two different reactions, viz.,

melanin pigment migration from the basal cells towards the superficial cells of the epidermis, induced by 280-320 nm radiation A photochemical radiation of a leuco (bleached) form of melanin may be involved in this second process, but since other agents, eg , ionizing radiation and various skin injury can cause melanization, the role of the UV radiation may be indirect, through injury of epidermal cells

Bioeffects of Non-Ionizing Electromagnetic Radiation

The non-ionizing electromagnetic radiations (NER) ranging from a few Hertz (Hz) to hundreds of Gigahertz (GHz) interact with biosystems by thermogenic and non-thermogenic modes of interaction The EM-bioeffects depend on frequency, fields strengths, far-field versus near-field, corporeal exposure and age and environment of exposure (Rai *et al.*, 1990, Adair, 1987) Dr Smith, in 1986, has theoretically determined the electromagnetic sensitivity of man and found that an average 70kg man could theoretically be sensitive to electromagnetic field as low as 8 V/m and 300 fT, corresponding a power density of less than 1pW/cm^2 (Smith and Best, 1989). Moreover, it is to be noted that different organs of body interact differently on being exposed in the same field due to varying dielectric properties of the constituents and the parts of the body. In view of several factors and cofactors involved in coupling of EM-field with biosystem, the exact mode of EM-bio-interactions is still uncertain

Bio-Effects of Radio Frequency

The bio-effects from RF (Radio frequency) exposures have been attributed to significant energy transfer that results in appreciable induced currents and tissue heating. The non-thermal involvement of RF fields have been reported to alter a variety of cell constituents, including mitochandrial enzymes, active and passive membrane transport complexes and receptors (Cleary, 1987). High frequencies and pulsed fields are reported

to cause current flow through cell interior, increase the conductivity and permeability of cell membrane and form pores in the cell membrane (Zimmermann *et al*, 1984) Alternating fields of appropriate frequencies and intensity or pulsed fields can produce stimulating effects upon ion uptake, DNA synthesis and cellular transcription The EM-fields have also been noted to change the genetic apparatus of cells (Markov, 1984) EM radiations are also reported to suppress the immunological systems, stimulate tumour growth and lower the host resistance to bacterial and viral infections, the effects depending upon natural conditions of exposure, field strength and characteristics (Smialowica, 1987)

The available data indicate that RF-fields cause various and varied cellular (Cleary, 1987), thermo-physiological (Adair, 1987), teratogenic (Lary and Conover, 1987) and immunological (Smialowica, 1987) effects. Most of these effects have also been reported in humans by Rai *et al.* (1990, 1992) at low environmental levels Among disease symptoms from RF-exposure, mention may be made of recurrence of bacteria and viral infections, cancers, spontaneous abortions, births of mentally and physically retarded babies, abnormal blood pressure, body weight loss, memory loss, eye sight defects, irritability, excitation, insomnia, alertness loss, depression, indigestion, etc

Bioeffects of ELF

As mentioned, the ELF radiation increases at sunspot maxima and causes several disease symptoms Several studies show that the low frequency Schumann band radiation (below 300 Hz) from the upper atmosphere appears to be of particular importance in relatioon to biological rhythms and has a frequency spectrum which resembles that of the human (EEG) brain waves. In electrotherapy, the frequency 27.5 Hz, 55 Hz, 110 Hz, 220 Hz, 440 Hz, and 880 Hz are said to be extremely effective (Smith and Best, 1989) In interferential therapy (Savage, 1984) frequencies 0-5 Hz affect the

sympathetic nerves, 0-10 Hz affects the unstripped muscle, 10-15 Hz affect the motor nerves, 90-110 Hz affect the sensory nerves, and 100-150 Hz affect the parasympathetic nerves

The beneficial effects of 55 Hz has been found The frequency of 5 Hz is usually regarded as being depressive, while the range 8-10 Hz is associated with well being and general alertness Dr Andrija Puharich (1962,1986) mentions that frequency of 8 Hz appeared to be of importance as an agent of self organization and generation of novelty According to O'Keefe and Nadel (1978) - the narrow band of theta frequencies between 7 5 and 8 5 Hz is said to be responsible for the suppression of ongoing behaviour upon receipt of signals of novelty, punishment, or omission of anticipated awards and for the processing of new information under these conditions

The bioeffects of extra-low frequency current induced from the fluctuating magnetic fields in the frequency range of 10^{-5} to 10^{2} Hz (10^{-3} to 10^{-7} Orested) during the peak of the solar cycle may be simulated with other experimental results. The ELF health effects are found time-related and cumulative, depending upon length of exposure (Wilson, 1988) The exposure to ELF causes lassitude, headaches, peculiar odder feeling, mental barriër and blockage, depression, rashes, epilepsy, headache across the eyes, exhaustion, sleeplessnes, loss of appetite, occasional dizziness, palpitation of heart, with trembling especially in extremes of wet, windy, very cold or very hot weather, abnormal pregnancies, suicidal tendency, thyroid troubles, sight defect, cataract, tumours, nausea and bleeding from eyes, Ocular effects and disturbances of circadian rhythms (Wilson, 1980; Wever, 1973). Rochard (1964) mentions that the potential thus induced may be several times larger than that necessary for triggering the nerve impulses.

Beischer *et al.* (1977) in 1973 found that exposure to alternating magnetic field of 45 Hz and 100 μT results into a rapid build-up of serum triglycerides in

man, an accepted warning of potential heart problem In several studies with ELF at or above 0 25 μT of magnetic fields have been found to cause and promote al. types of cancers in general and brain cancer, all types of leukemia and lymphoma, in particular (Nair and Morgan, 1990) Current theories of carcinogenesis hold that tumour formation involves at least two stages, called initiation and promotion In initiation, the deoxyribonucleic acid (DNA) in the cell nucleus is disrupted by an external agent, producing abnormal DNA that leads to formation of abnormal proteins, and finally cell dysfunction Initiation requires considerable energy to break the chemical bonds of DNA - more than this is available in the ELF fields

The unequivocally demonstrated effects of ELF fields on mammals involves changes in the internal biological clock or circadian rhythm These are most clearly reflected in the secretion pattern of a hormone known as pineal melatonin, which is secreted by tiny pineal gland in the brain A neuroendocrine transducer, it translates an electric signal from a nerve cell into a hormonal (or endocrine) secretion The exposure to ELF has been found to suppress the pineal melatonin levels

In mammals, light entering the eye produces the electric signal that initiates the pineal melatonin cycle This is the basis of one of the main time-keeping systems of the body, which in humans is responsible for the daily sleep-wake cycle Phase shifts in this cycle change internal phase relationships between various circadian rhythms of the body and cause some psychiatric disorders, including depression. Dysfunction of circadian can also affect task performance The pineal gland and melatonin levels also help inhibit growth of, eg , skin cancer and certain types of breast cancer. The ELF field exposure promote cancer by suppressing the pineal melatonin.

The field strength threshold of 5 V/m from ELF (60 Hz) induced field causes release of calcium ion from brain tissue (Cleary, 1987, Nair and Morgan, 1990)

Ornithine decarboxylase (ODC) is an enzyme present in all cells and is essential to cell growth ODC activity is another cellular process that can be affected by ELF Because of excessive growth activity in cancer cells increased ODC activity is often used as an indicator of cancer promotion The ELF (60 Hz) is found to increase the ODC (the experimental results of Craig Byus and Christopher Cain, as reported by Nair and Morgan, 1990)

While they cannot directly damage DNA, ELF field of the order of milligauss can change the rate of DNA synthesis in certain human cells, according to an experiment by Abraham Liboff and co-workers at Oakland University in Rochester, Mich Under the influence of the fields, new proteins are formed, and quantities of proteins are changed so as to produce more shorter and a fewer longer molecules The nature of change depend at the frequency of the field

The ELF fields have also been shown to influence the action of parathyroid hormone, which affects the growth, and among other things, some steroid hormones that mediate stress responses and anti-inflammatory activities Regarding the mode of biointeraction of ELF weak magnetic fields, two research groups have independently suggested an intriguing theory that scientists say worth taking seriously Speaking in July, 1990 at the Bioelectromagnetic Society in San Antonio, Valeri Lendev proposed that a weak oscillating magnetic field could loosen the bonds between metal ions and some proteins in the body Many proteins vital for metabolism contain metals

Two British researchers John Male and Donald Edmonds also aired a similar theory. The key observation seems to be that the biological effects only happen around particular frequencies of the oscillating magnetic field. What is more, these frequencies seem to depend on the presence of a steady bckground magnetic field such as that of the Earth These conditions are reminiscent of a phenomenon that is called cyclotron resonance.

If a free charged particle moves in a constant magnetic field, it accelerates so that its path bends into a circle The frequency at which the particle circulates, the so called cyclotron resonance frequency depends on the mass and charge of the particle and on the strength of the field Add a second magnetic field that oscillates at the same frequency and the particle accelerates further, an effect exploited by particle physicists in accelerators

When biophysicists experimented on various living cells, using steady magnetic fields and oscillating weak magnetic fields, they observed biological effects They found that the most effective frequency corresponded to the cyclotron resonance frequency for a particular ion, calcium,an extremely important metal in living systems It seemed that the cyclotron resonance frequency of calcium could be the link between magnetic fields and cells in living creatures, including humans

Unfortunately, this theory was shot down by several objections : first, the radius of the cyclotron orbit for the calcium ion at one metre is very large A calcium ion affected in this way in an organism would collide with another molecule in the cell before making even a fraction of one orbit Also, in a biological environment, the calcium ion would be surrounded by tight cell of water molecules that would alter its cyclotron frequency any way.

The new approach discussed at San Antonio seems to be more plausible. It considers what happens to a calcium ion bound in a calcium binding protien, calmodulin, when placed in static and oscillating magnetic fields. The ion is continuously vibrating about its equilibrium position in its binding site. Applying a steady magnetic field causes the plane of vibration to rotate, or precess, about the direction of magnetic field at a frequency that is exactly one half of the cyclotron frequency of the bound ion.

According to the British and the Soviet researchers,

adding a wobbling magnetic field at the cyclotron frequency disturbs the precession to such an extent that it could loosen the bond between the ion and the protein Thus, if certain levels of magnetic fields could cause biohazards, the ambient levels on the contrary could lead to therapeutic applications by modifying the calcium ions For many diseases can be attributed to too littel or too much calcium in the body (Coghlan and Hall, 1990)

Bioeffects of Magnetic Fields

Life originates and evolves in conditions, which include magnetic field. Pavlovitch (1971) showed that these are serious grounds for considering the geomagnetic field a factor which strongly influences the course of evolution. It seems quite probable that, just because of that, all living organisms are very sensitive to small changes in the electromagnetic environment. Recently, evidence has been published for the existence in some species of structures including magnetic material. Such magnetic material often identified as magnetite, has been discovered in bees (Gould, *et al.,* 1978), homing pigeons (Walcott, *et al.,* 1979), dolphins (Zoeger, *et al.,* 1981) and various other organisms including man (Kirschvink, 1981). Baker *et al.* (1983), report that bones from the regions of the spheroid/ethmoid sines complexes of humans are magnetic and contain deposits of ferric iron. The magnetic materials sensitivise the livings to magnetic field.

As mentioned, there occurs geomagnetic fluctuations in varying order in space and time at each 11-years sunspot cycle. From the experiments of Rochard (1964) it may be inferred that the bioeffects of such geomagnetic fluctuations would be more in those regions characterized by geomagnetic anomalies The effects of geomagnetic perturbations may be inferred from the following experimental results conducted in both constant and oscillating magnetic fields.

ELF Weak Magnetic Field Bioeffects

Perry *et al.* (1981) report that magnetic field bio-effects depend not only on the strength of the field but also on its frequency The ultra-weak magnetic field fluctuations in the 0 01 Hz to 10 Hz region with amplitudes of 5 nT to 50 nT have been found to produce effects in human subjects (Smith and Best, 1989) Low level pulsed magnetic fields affect the permeability of cell membranes (Braganza, *et al.*, 1983)

Bioeffects of Constant Magnetic Field (CMF)

The influence of constant magnetic fields on biological systems with different levels of organisation has been shown in many experiments with microorganisms, plants and animals Data on influence of magnetic field on microorganism are comparatively limited and unclassified However, the various opinions can be classified into three major groups (1) The magnetic field is mutagenic factor for microorganism (2) The magnetic field sharply changes the activity and direction of action of different enzyme systems (3) As a result of the influence of the magnetic field microorganisms can achieve new properties

The considerable evidence for the serious changes in living activity of cells under an electromagnetic field paved the idea to suggest that magnetic fields may influence the genetic apparatus of cells (Pavlovitch, 1971) The effectiveness of the magnetic influence strongly depends on the magnetic induction and exposure time and is at a maximum at B = 45 mt and t = 30 min (Markov, 1984).

During the last few years, new data have been obtained on the biological significance of the constant magnetic field in reproduction and growth of micro-organisms. Changes in morphological cultural properties were also observed (Pavlovitch, 1981).

Many investigations relate to the magnetic field influence on mammals Kholodov, (1975) considers that

the nervous system is the first which reacts to the electromagnetic fields According to Nachilnitzkaja and Smirnova (1978), the endocrine and especially blood systems participate in the realization of the magntic field influence According to their participation in the magnetobiological reactions different system may be arranged in the following order nervous, endocrine, organs of sense, heart vessel, blood, digestion, muscle, secretory, respiratory, skin, bone (Kholodov, 1982) On the other hand, *in vitro* experiments show that practically every organ reacts to the magnetic field influence

Magnetic fields have a mostly inhibitory effects on the nervous system–suppressing conditioned and unconditioned reflexes, altering the encephalogram in favour of slow rhythms, and reducing the frequency of electrical discharges by some neurons. Of the sections of the brain, the hypothalamus and cerebral cortex are highly magnetosensitive The output of the pituitary of certain hormones are altered. Significant morphological changes have been observed in gonads (especially males), adrenal and thyroid Changes in the circulatory system are manifested in vascular dialation and hemorrhaging

Unfortunately, the primary mechanism of magneto-biological reaction has not been clarified until now. The fact that magnetic fields introduce into biological systems a relatively low amount of energy is very significant The cooperative character of many bio-physical phenomena leads to the idea of approximately triggering mechanism of biological action of CMF The magnetic field could be regarded as such a factory which brings the system from a state "yes" to a state "no" and the course of many important biochemical processes is dramatically changed.

Likely loctions for amplification and extension of weak electrochemical triggering events at the cell membrane may involve glycoprotein molecules on the external surface of the plasma membrane especially those molecules that constitute specific receptor sites for

various extracellular molecules (Adey, 1975)

On the level of biological macromolecules, results showing the influence of MF on nucleic acids and proteins (Shepard and Eisenbud, 1977), Krasnogorskaja, 1978, Kholodov, 1978, Chiabrena *et al*, 1979, Pilla, 1980, Markov, 1981, Pavlovitch, 1981, Becker and Marino, 1982, Colacicco and Pilla, 1983) are important Changes in enzyme activities were observed and these changes are considered as factors responsible for the magnetobiological reactions of the living systems (Haberdtzl, 1967, Kholodov and Shishlo, 1979)

Some scientists (La Warr and Baker,1967,Battocletti, 1976, Shepard and Eisenbud, 1977, Tenforde, 1979) consider the ability of MF to induce electric currents as a main possibility for MF to influence biological systems The characterization of the impedance of the cell membrane is very important for the estimation of the biological significance. Usually plasma membrane (and other organelle) surfaces exhibit electrical charge separation giving it capacitor like-properties. The structure of this capacitor is determined primarily by the interactions of water molecules and hydrated ions and chemical groups associated with the various lipids, protein and carbohydrate compounds of the membrane

One of the most probable mechanisms for the explanation of magnetic influence on biological system is through changing the microstructure of water taking part in all biological structures. In a number of experiments, significant changes in different level of organization in biosystems (microorganism, plants and animals) were observed (Markov, 1977, 1981). Both direct and indirect (by preliminary magnetic treatment of water) influence take place. One specific dependence on the value of magnetic induction has been observed the optimum of effects at B = 45 mT It has been regarded as a "Resonance" mechanism of the magnetic field influence. When the constant magnetic field has an induction equal to that necessary for the transition, the system

achieves a "Stationary" state at which it can remain for a certain period of time Any other energy will bring the system to a state different from the "Stationary" one Because of the fact that the system intensively exchanges energy with the environment, the observed effects are lower and at the same time they quickly disappear at these "non permitted" states The hypothesis for the possible realization of magnetic influence through water is discussed in number of paper (Kholodov, 1975, Klassen, 1978, Kholodov, 1978, Kholodov and Shishlo, 1979, Pavlovitch, 1981, Kholodov, 1982)

It is probable that CMF plays the role of stabilizing factor which promotes the structuring of the biological liquid and bio-colloids (Markov and Kantcheva, 1982) It is also possible that CMF modifies membrane transport In this idea (Markov, 1983) the key is the existence of aggregates of water molecules around the membrane CMF may stabilize these aggregates or destroy them (depending on the value of magnetic induction). Thus, changes in membrane transport may arise.

In a recent experiment conducted by the author himself and N.N Singh and K.K Rai, it was found that magnetic poles have different effects on biosystems The direct and indirect (through water) exposure of seeds to north pole led to early germination, faster growth rates, more healthy plants with reduced life cycle than that to south pole and north x south poles The seeds induced by the north pole developed into plants with violet colour. Similar colouring effect was also observed on plants irrigated by water exposed to north pole of the magnet; the south north + south poles produced green plants.

The biochemical screening of the plants thus produced showed that carotenoid and chlorophyll ratio was more than unity in plants induced by the north pole, whereas south and north + south poles exhibited slightly more clorophyll content.

In the experiment it was also noted that north pole plants were negligibly infested and that the south and north-south pole plants harboured severe insect pests Further, the synergistic effects of certain insecticides by the north pole was found to be more lethal than that by south and north (+ south poles (Singh *et al* , 1991)

From the resulting colour of the plants, it may be inferred that the polar fields restructure the bio-systems (seeds), at molecular level and the restructured biomolecules form the basis for "memory bits" of the characteristic magnetic field signature that determine the rate and direction of the biological effects It seems likely that polar effects are realized at first by live water, which while taking part in biochemical reactions imprints the characteristic signature on the biosystems. The restructured water by north pole has been noted to absorb ultra-violet (UV) radiations with marked shifts towards lower wavelengths i e form "B" band to "C" band and increasing quanta of absorption with length of exposure to the field The south pole produces the contrary effects and that of the north + south poles, the combined effects i e absorption and emission both

The UV absorbance may be attributed to water monomers. Water exposure to magnetic field results into varying time-dependent water structures ranging from monomers of higher energy for south pole and lower energy for north pole than the normal through cloth rate hydrate frameworks to liquid crystals for the dipoles These structures were suggested to be responsible for the long term field memory bits in liquid water (Rai *et al.*, 1992). These water structures were found to produce time dependent varying and different bioeffects for the dipoles (Rai *et al.*, 1992)

Since north-pole water also absorbs the UV-B and UV-C, deadly synergistic effects produced by this pole may be attributed to combined property of the 'hot ions' and the insecticides.

Mode of Bio-interaction of Restructured Water

Water is the medium in which life originated and in which all organisms still exist The living cell consists largely of water and literally floats in water

It plays a fundamental role in the protein molecule, the basic material of the living matter Proteins have a structure which places them in the class of substances known to chemists as plastics In order that a plastic may possess flexibility and other desirable physical properties, it must contain a fluid called a plasticizer Water is a "plasticizer" for proteins In the chain-like protein molecule, the hydrogen bonds of water provide secondary links which fix the pattern of the molecule Removal of water alters the pattern and "denatures" the protein On the other hand, the hydrogen bonds of hydrides other than water, such as ammonia or hydrogen cyanide, form a stable denatured configuration, which freezes the protein in a dead pattern This is why all the hydrides except water are extremely toxic Their action is somewhat like that of a virus, which corrupts the true protein structure into a strange distorted pattern (Buswell and Rodebush, 1956)

As indicated, electromagnetic fields change the structure of water Hence one likely mode of bio-interaction through restructured water could lie in changes of pattern of protein molecules, in effect that may demonstrate many biochemical and physiological changes in the living system. Since different fields produce different structures to water, the cumulative effect will depend on their characteristic electromagnetic signatures in water

Del Guidice *et al.* (1988) propose that if the dimensions of regions of coherence in water correspond to a 100 nm wavelength the critical magnetic field for one quantum to link each of them is of the order of 100 nT. This implies that the threshold for any effects associated with restructured water in a living system will be of the order of 10 nanotesla.

Water has a very high dielectric loss, so there should be no electrical resonance in an aqueous environment But Edwards *et al* (1984) have found extremely intense and sharp absorption resonances in the microwave region for the DNA extracted from E coli relative to that of the aqueous environment, confirms the theoretical predictions of Prohofsky and co-workers Genzel *et al* (1986) have proposed a longitudinal acoustic mode model which can account for all the experimental facts

The physical properties of 'structural water' that is, water in close contact of biological systems, are regarded as being between those liquid water and ice and capable of giving broad-band absorption, but the above resonances are too sharp to be so attributed Van Zandt (1986) has constructed a simple mathematical model which was so successful at describing such DNA resonances in water

In view of the above, another mode of biointeraction of restructured water could arise from the field dependent shifts and changes in absorbance and resonances of the naturally available electromagnetic radiations in the system It is also evident from 'our experimental results,showing different colours of the plants and corresponding EM-interaction of the 'restructured water'

CHAPTER 8

KUMBHA MELA AND COSMOBIOLOGY

As indicated in the preceding chapter, various planetary configurations concerning the world famous *Kumbha* is related with the sunspot cycles, and that of the ceremonial bath, with lunar phases In the present chapter, the biological effects of these have been dealt with.

It deserves mention that the *Purna* (Full) *Kumbha Mela* generally recurs at the interval of about every twelfth year at Hardwar, Prayag, Ujjain, and Nasik. The *Kumbha Mela* cycle at these places variously synchronizes with the different stages of the sunspot cycle, averaging between 11-12 years (Foukal, 1990).

A retrospect into the history of the solar cycle and that of the *Mela* (table 7) shows that the *Mela* at Ujjain and Nasik generally occurs ranging from approximately one to 2 years before or at the sunspot maxima of each solar cycle It needs to be recalled that the *Purna Kumbha Mela* of these two places coincides with the *Ardha Kumbhas* of Prayag and Hardwar. The record also demonstrates that the *Mela* at Prayag occurs either at sunspot maxima or 3 years before maxima or at commencement of a new cycle Moreover, it may also occur within three

years of the declining phase of any cycle Similarly, the *Mela* at Hardwar coincides either at maxima or approaching maxima, or at extreme end of the concerned cycle, or at the very beginning of a new cycle

Table 7

Solar Cycle (from 1713-1992)			*Kumbha Mela* Cycle			
Maxima	22 Yr cycle	Minima	Hardwar	Prayag	Ujjain	Nasik
1716		1713				
1726		1723				
1738		1734				
1750		1756	1750			
1761	1761	1763	1761			
1770		1775				
1779		1785				
1788	1783	1797				
			1796			
1803		1810				
	1805					
1816		1823				
	1827					
1828		1833				
1837		1843				
	1849					
1848		1856				
1859		1866				
1870	1871	1878				
1883		1888				
1893	1893	1901				
1906		1913		1906		
	1915		1915			
1918		1923				

1928		1934	1927	1918	1920	1921
	1937			1929	1932	1933
1938		1943	1938	1941		
1946		1953			1944	1945
1958		1963	1950			
1969		1973	1962	1954	1956	1957
1980	1981	1984	1974	1965		
1992		1994	1986	1977	1968	1968
2003				1989	1980	1980
					1992	1992

(After Foukal, 1990)

Heliobiological Perspective of the *Mela*

The varying spatio-temporal setting of the *Mela* seems corresponding to the heliobiological effects of sunspot-cycles To appreciate the cosmobiological effects, an analysis of the spatio-temporal setting of the *Mela* in terms of Earth-Sun line relationship and solar radiation budget, deserves special attention Because, the heliobiological effects are caused by the radiant solar energy that varies in space and time, and also in quality in conjunction with Earth-Sun relationship

Sun-Earth Line Relationship

The electromagnetic radiations and charged particles from the Sun are not emitted radially and their paths are seriously distorted by the magnetic fields of sunspots themselves This, in turn, may account for the fact that after sunspots will appear on the Sun with no comparable magnetic or radio disturbances taking place on Earth. Under such conditions, the paths of the ejected radiations may be so distorted when they are emitted from the sunspots as not to encounter the Earth at all. It needs to be emphasized that the Sun is million times as large as the Earth, and that the size of the Earth as seen from the Sun would appear as big as a pinhead seen at a distance 12 meter from the eye It

deserves mention that as radiations from the spots may sometimes swing high or low as they pass the central meridian, a situation noted for maximum effects, one could imagine that the Earth may not always be in a position to receive even a part of the stream of corpuscles ejected Under such circumstances then, a sunspot of considerable size might pass across the solar disk without any noticeable effect on Earth

On some occasions, magnetic disturbances and even displays of the aurora have occured after a spot has crossed the solar surface and, by virtue of the Sun's rotation has actually disappeared around the edge of the Sun It appears probable that under such circumstances a stream of particles ejected by the sunspot may have been so curved at the outset that the magnetic field of the spot itself had actually bent the stream around toward Earth's direction after the spot ceased to be visible on the front side of the Sun

The magnetic and atmospheric disturbances on the Earth generally occur on days when spots have averaged positions near the central region of the Sun's disk As mentioned, sunspots appear at lower latitudes on the Sun, that is, nearer the solar equator as the sunspot cycle progresses For a given amount of sunspotedness, the chances, therefore, are greater for more cosmic effects immediately following a sunspot maximum than before one. The effects are caused when a huge groups of sunspots break out on the surface of the Sun, a stream of electrified particles reaching the Earth can so heavily ionize the upper layers of the air to create sufficiently high electrical voltages and to cause visible discharges through rarified air resulting into auroras Every auroral occurrence is accompanied by geomagnetic disturbances The magnetic disturbances are accompanied by heavy electrical currents induced in the Earth.

Various attempts have been made to relate given radio and magnetic disturbances to the location of the individual spots on the surface of the Sun Anderson

(1939) has attempted to relate terrestrial disturbances to the appearances of the particular sunspot for interval of from a few days to as much as three months after the origin of the spot in question To predict how near a given spot, when first seen on the eastern edge of the Sun, may come to the Sun-Earth line, one should take into account the Sun's rotation about an axis inclined 7° to the plane of the Earth's orbit This inclination of the solar axis results in different paths which the spots will apparently pursue across the Sun's disk as the Sun rotates.

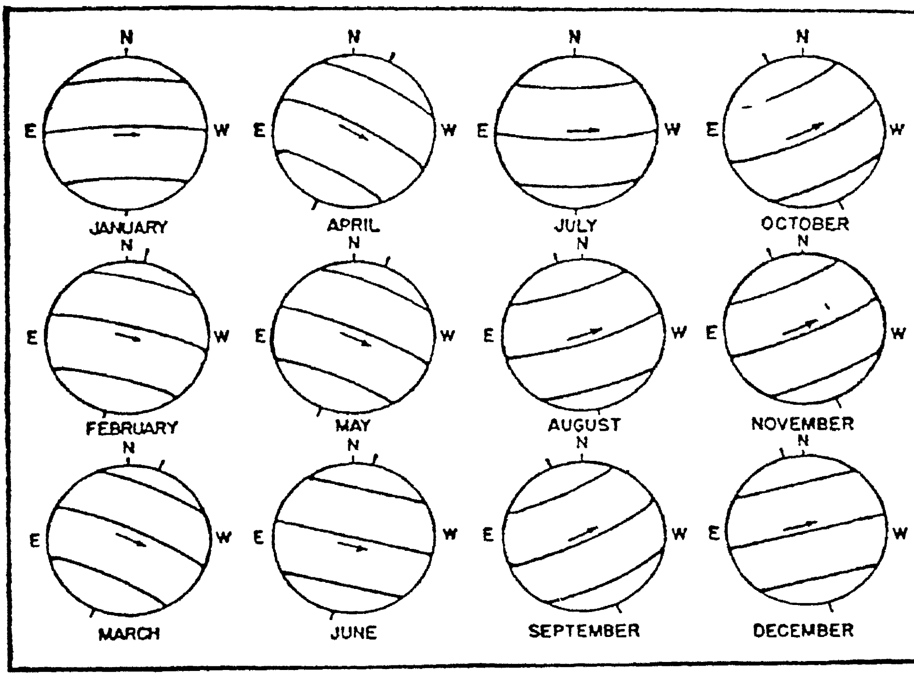


Fig. 18. *Positions of sunspot zones and solar axis for each month of the year (Arrow shows direction of solar rotation)* (After Stetson, 1947).

In figure 18, there is represented the location of the

sunspot zones as the Sun's surface presents itself to the Earth for each month of the year These diagrams are drawn so that the point N always represents the north point of the Sun directed towards the north pole of the heavens The solar axis, as seen from the Earth, coincides very nearly with this north-south line in January and July, but in January the north end of the Sun's axis is tilted away from the Earth, whereas in July it is tilted toward the Earth This may be inferred from the direction of the curvature of the Sun's equator and that of the boundary lines of the sunspot zones, in both the northern and the southern hemispheres In April, the solar axis is at a considerable angle to the north-south line, the north point inclining toward the west. In October, the solar axis is tilted so that its north end is inclined a similar amount to the east It is only in June and December that sunspots transit the Sun's disk in sensibly straight line By referring to this one may visualize a spot appearing on the east limb, and in advance, how near the centre of disk, or Sun-Earth line, the spot will be carried by the Sun's rotation It has been estimated that on the average it takes thirteen days for the spot to be carried from the east to the west limb of the Sun It deserves mention in connection with auroral displays that the magnetic and radio disturbances are more often experienced just after a given spot has crossed the central meridian passing through the solar axis It is statistically valid that the nearer the spot passes the centre of the Sun's disk, the more likely we are to experience terrestrial disturbances (Stetson, 1947)

The *Purna Kumbha Mela* at Hardwar recurs either at sunspots maxima, or approaching maxima, or at the end of a cycle, or at the beginning of a new cycle in the months of March-April, during which the solar axis is at a considerable angle to the north-south line, the north point inclining towards west. In view of these, the cosmic terrestrial effects and thereby cosmobiological effects may vary from occasion to occasion at this place

It needs to be recalled that the solar output of extra-ultraviolet (EUV), extra low frequency (ELF) radiation, radio frequency (RF) with increased strength in amplitude, X-rays, gamma rays, and electrically charged particles increases at sunspot maxima, which perturbs the magnetosphere and ionosphere, which in turn, perturbs the geomagnetic field and induces electric currents in the near terrestrial space and at the surface of the Earth, and causes auroras in the Earth's environment The sunspots are reported to produce violent terrestrial effects when occurring parallel in line with Earth, ie at the equatorial regions on the Sun, and during 13 days period of latitudinal passage from east to west through the solar disk (Stetson, 1947, Eddy, 1978) The geomagnetic perturbations produced under the conditions vary in a broad range of frequencies from 10^{-5} Hz to 10^{2} Hz and amplitude from 10^{-3} to 10^{-7} Orested, as against 30-300 gammas and 1-5 gammas (1 gamma = 10^{-5} Orested) at low and mid latitudes, and therefore at the *Mela* sites, during the "quiet" period Fewest number of auroras are reported four years before the sunspot maxima, for in the beginning of a cycle spots are located at higher latitudes on the Sun (Stetson, 1947) The largest number of auroras, accompanying ionospheric and magnetospheric perturbations and penetration of ELF, ultraviolet, etc, into Earth's environments, are reported two years after sunspot maxima (Snyder and Neugebauer 1963). Because, as the sunspots begin to wane after the year of maxima, they are invariably occurring in regions on the Sun progressively nearer the solar equator, and for this region will more nearly pass in line with Earth as they are carried across the disk by solar rotation.

In light of the above, the cosmic terrestrial effects, and in turn, cosmobiological effects at different conditions during *Kumbhas* may be outlined as follows :

The westward titling of north point of Sun during

the months (March-April) of *Mela* results into non-alignment of Earth-Sun line Therefore, the helio-terrestrial effects at maxima-Hardwar *Purna Kumbha* would be caused by a comparatively increased level of solar radiations Because of Earth being neither in line with sunspots, nor in the line of latitudinally passing spots from east to west due to tilting at the maxima-occasion, there is less likelihood for violent and recurrent electromagnetic perturbations at the Earth and its environment, and hence the related heliobiological effects The heliobiological effects at the approaching maxima - Hardwar *Kumbha* would be caused by the above radiations and recurrences of strong geomagnetic perturbations and induced currents in the near terrestrial space and at the surface of the Earth Because of westward tilting of the north point of the solar axis, the eastern higher latitudinal sunspots may reach parallel or in close proximity to Earth-Sun line thereby presenting an ideal condition for maximum cosmic effects on Earth This condition also presents most suitable situation for the violent cosmic terrestrial effects by latitudinally passing spots

The heliobiological effects from sunspots at Hardwar *Kumbha* recurring at extreme end of the cycle would be minimal, because of the reduced characteristic solar radiation at the extreme end Further since the Earth lies away from north-south line, the effects of latitudinally passing spots through solar disk will not be felt at Earth

The "Coronal holes" at the eastern latitude of the Sun being in Earth-Sun line due to westward tilt of the Sun, may however, contribute to geomagnetic activities and therefore to biological effects. The Coronal holes are always present near the solar poles, but they can evolve at low latitudes Low latitude holes produce high velocity solar wind streams that can spray the Earth directly and recurrently as the Sun rotates It has been found that the largest low latitude holes develop during

the declining phase of a cycle, so that their contribution to geomagnetic activities is greatest a few years after the peak of sunspot maxima (Foukal, 1990) As mentioned, sunspots develop at higher latitudes in the beginning of a new 11-year cycle and as the cycle progresses towards maturity, they gradually move towards equatorial region and only from where they produce terrestrial effects due to be in Earth-Sun line Because of the higher latitudinal positions of a few sunspots, and also away from the north-south line, there shall be no potential bioeffects of the above kind during the *Mela* coinciding a new cycle

It needs to be recalled that cosmic-terrestrial effects in the month of March would be different from that of succeeding month due to galactic exposure of the Earth at its maximum speed Thus the cumulative galacto-heliobiological effects during March would be quite peculiar and different from other months related to the *Kumbha Mela.*

The *Purna Kumbha Mela* at Prayag recurs either at sunspot maxima or 3 years before maxima or at the commencement of a new cycle in the months of December and January. In December the northern end of the solar axis is tilted slightly toward east and sunspots transit the solar disk in a sensibly straight line. In January, the north end of the Sun's axis remains tilted away from the Earth, though solar axis coincides very nearly with north-south line. Thus, during the occasions of Prayag *Kumbha,* the terrestrial effects will vary as per coincidences with the different stages of cycles, and also between both the months.

At 11-year cycle-maxima- Prayag *Kumbha*, the biosphere may experience maximum heliobiological effects produced by the characteristic radiations coupled with electromagnetic perturbations of Earth and its environment in the month of December. It is because, of the eastward tilt of solar axis the sunspots of the western latitude come parallel to the Earth-Sun line, whereby

they represent an ideal condition for maximum terrestrial bioeffects (Eddy, 1978) Moreover, the above situation also presents an ideal situation for the terrestrial effects produced by straight line passage of spots from east to west on the solar disk

The terrestrial bio-effects on the Prayag occasion occurring 3-year before maxima will be similar to the above, but less in intensity due to aligning of smaller number of western latitudinal sunspots on Earth-Sun line from the eastward tilt of the solar axis and occasional straight line passage of spots through the Earth-Sun line For example, some terrestrial effects by latitudinal passage of a large group of sunspot was noted during Dec 1989, coinciding the *Maha-Kumbha* at Prayag three years before maxima of the present cycle to be completed in 1992 (Foukal, 1990) For the reasons explained above, there will not be any notable heliobiological effects of the above kind during the Prayag *Kumbha* recurring at the commencement of a new cycle

As the northern end of the solar axis faces away from the Earth in the month of January, the cosmic factors (electromagnetic) responsible for the effects in December will fall below the threshold of the potential effects in January The electromagnetic gradients thus established in both months may cause more potential bio-effects, but varying in nautre in accordance with the stage of the solar cycle. Rochard (1984) also reports the bio-effects of potential gradients

The *Kumbha Mela* at Ujjain recurs either at sunspot maxima or at one to two years before maxima in the months of May-June, during which the north axis of the Sun is tilted towards west. The sunspots also transit the Sun's disk in straight line during June Though the westward tilt disturbs the Earth-Sun line, it brings the eastern higher latitudinal sunspots in line with Earth, whereby they may spray the radiations over Earth and could produce potential heliobiological effects There may occur violent terrestrial effects (heliobiological)

by the latitudinal passage of sunspots The chances for which are occasional in May and recurrent in June due to straight line passage of spots Because of similar Sun-Earth line situations, helio- terrestrial effects at maxima *Mela* here will resemble the maxima effects at Hardwar

The Nasik *Purna Kumbha Mela* recurs either at sunspot maxima or at one year before maxima in the months of August-September During these months the northern end of the Sun's axis is inclined towards east, the tilt is more in the latter month Due to similar Sun-Earth line situations, the helio-terrestrial effects during the occasions here will resemble those of Prayag at the above stages of sunspot cycle, but differ during the latter month due to galactic exposure of the Earth at minimum speed. For being the Earth farther away from the line of western latitudinal spots due to more axial tilt, the helio-terrestrial effects during the latter month from the direct radiations of spots will be less in intensity. However, the electromagnetic gradients between the two months may be biologically significant.

The *Ardha Kumbha Mela* at Hardwar and Prayag is held in the years of the *Purna Kumbha* at Ujjain and Nasik In view of it, the helio-terrestrial effects on the occasions will be similar to their *Purna Kumbhas,* but depending upon the stages of the solar cycle for Nasik and Ujjain

Since the cosmic effects are caused by the characteristic solar radiation, it is also necessary to examine the same in spatio-temporal framework of the *Melas* to appreciate the energy budget based variations in cosmic effects. Based on the data of the solar radiation over India (Mani and Rangarajan, 1982), a computation of solar radiation at each *Kumbha* sites for the whole year and during the months of the *Mela* is presented in table 8.

Table 8

Sites	Hardwar	Prayag	Ujjain	Nasik
Latitudes	29°56′	25°42′	23°10′	20°0′
Months of the *Mela*	Mar-Apr	Dec-Jan	May-Jun	Aug-Sep
Mean daily hours of sunshine distribution at the sites in the months of *Mela*	8-8 5	8 0	9.5	4 5
Mean daily solar radiation at the sites in the months of *Mela*	5 9	4 3	6 9	5.0
Cleanness index at the *Mela* sites	0.62	0 64	0 64	0 62
Annual mean daily diff used solar radiation at the *Mela* sites (kWhm^{-2}day^{-1})	2.2	1 8	1 8	2.4
Annual mean daily solar radiation at the *Mela* sites (kWhm^{-2}day^{-1})	5 4	5 8	5 8	5.8
Annual mean daily hours of shunshine distribution at the *Mela* sites (kWhm^{-2}day^{-1})	8-8 5	8.5	8 5	8.5

As this table shows, the distribution of annual mean daily hours of sunshine is 8 to 8.5 at Hardwar and 8.5 at other places. The distribution of annual mean daily global solar radiation (in KWh m^{-2} day^{-1}) is 5.4 at

Hardwar and 5 8 at other *Kumbha* sites The distribution of annual mean daily diffused solar radiation (in KWh m^{-2} day^{-1}) is 2 2 at Hardwar, 1 8 each at Prayag and Ujjain and 2 4 at Nasik The hours of mean sunshine distribution during the months of *Mela* at Hardwar (March–April) is 8 5, at Prayag (December–Jan) is 8, at Ujjain (May–June) is 9 5, and at Nasik (August–September) is 4 5 The mean daily solar radiation (in KWh m^{-2} day^{-1}) during the months of the *Mela* is 5 9 at Hardwar, 4 3 at Prayag, 6 9 at Ujjain and 5 at Nasik The distribution of mean cleanness index at Hardwar, Prayag, Ujjain and Nasik is 0 62, 0 64, 0 64, and 0 62, respectively

An examination of the north south line and paralleling of the equatorial sunspots in line with Earth shows that the *Kumbhas* at the four places represent cosmic terrestrial effects of reversing magnetic polarity of the spots in a cyclic order in time and in space, and also of galactic exposures As the reversal of magnetic polarity causes droughts accompanying "dust bowl" at 22-year cycle and the 11-year cycle with less severe droughts (Eddy, 1978), it may also produce other mentioned helio-effects characterizing the polarity of the latitudinal spots The dipolar bio-effects have been found to different and time-dependent (Rai *et al.*, 1992) in terms of latitudinal alignment of sunspots in line with Earth, the helio-terrestrial effects at Hardwar and Ujjain will be similar in nature by the radiations from the eastern latitudinal sunspots, and those at Prayag and Nasik by the radiations from the western latitudinal spots In light of the helio-effects, the *Ardha Kumbhas* at Hardwar and Prayag represent the *Purna Kumbhas* at Ujjain and Nasik, respectively.

But the *Saravali* mentions varying cosmobiological effects at the above occasions The varying cosmobiological effects may be attributed to spatio-temporally varying solar radiations, the quality and quanta of which are held responsible for producing cosmic terrestrial effects. Moreover, the differing cosmobiological

effects at Hardwar and Nasik *Kumbhas* may be due to noticeable decline and sudden enhancements in biocolloid reactions during March and September by the galactic radiations, when the Earth is directed with different speeds towards the galactic centre It is only during March, the Earth is directed approximately at maximum speed (minimum in September) towards the galactic centre, that is, along the lines of force of a radical field and perpendicular to the lines of force of a dipolar galactic field (Piccardi, 1962)

The above cosmobiological variations may also be attributed to differing biological effects of the concerned months of the *Mela*, characterized by specific bioeffects, and also to varying day-length of these months The day length have been shown to affect the circadians of living beings including humans There are ample evidence to such effects We know that migratory birds appear and disappear at specific times of the year, and that some animals hibernate in the winter An example of a combined daily annual rhythm is shown by migratory birds Many migratory birds increase their weight before they start their long flights, as they build up large deposits of fat which they use as food reserves *en route.* These fat deposits are laid down in spring, within about 10 days, and there is another period of migratory fattening in late summer, but the rate of gain is slower than in the spring Experiments have shown that the start of these periods is controlled by the changing of the day length which accompanies the seasons The winter hibernating creatures also accumulate fat to be consumed during the period

The bioeffects of other months can be also taken for example The palolo sea worms of the South Pacific have main sex cycle that occurs once a year, during the last quarter of the Moon in November, which correspond to spring in south. These worms have also been noted to have two risings : a small one in October and a large one in November. The echinoderms (family), deep sea inhabitant just off the coast of Japan, liberate their

sex cells just once a year in October, on the day of one of the quarters of the Moon Its cycle is such adjusted that the result is an 18-year cycle, called the Saros cycle (18 years and 11 3 days) which is linked to the motion of the Moon

As mentioned, this Saros cycle is the period after which relative positions of the Earth, Sun and Moon repeat themselves Due to this, the solar and the lunar eclipses also follow the Saros cycle The same sequence of events that is responsible for eclipses also causes changes in the behaviour of the tides, and the deep-sea creature is responding to these changes Some astrologers claim that the astrological effects of an eclipse can actually precide the eclipse itself (Seymour, 1988)

It has been found experimentally that most biorhythms are very stable and persist even after the organism is shielded from the external stimulus with which it is synchronized, but if the organisms is removed from its own environment for a long period of time the various parts which exhibit rhythms become desynchronized (Seymour, 1988) Therefore internal times have to be adjusted by external geophysical periods The cosmic things related with *Mela* could shield the stimulus to highly synchronized biorhythms for sufficient time and may desynchronize them The *Mela* further provides the opportunity to re-adjust the internal times to the signs of sunspot and cosmic events in the spatio-temporal framework

It is well known even to the layman that each day the body temperature reaches a highest value towards the evening and a low point in the morning. Since this phenomena was described by Gierse in 1842, many clinical and psychological studies have shown that there is apparently nò organ and no function of the body which does not exhibit a similar daily rhythmicity

Experiments by Jores and Frees showed that there existed a daily cycle in the tolerance of humans to pain, at least as far as the skin and teeth are

concerned Between the hours of 8 pm and 8 am the teeth are much less sensitive to painful stimulus than they are at other times of the day The sensitivity to pain reaches a maximum at about 6 pm There also exists a daily rhythm in the metabolism of alcohol in the body Between 2 pm and midnight, alcohol is burned up more quickly than during other hours of the day

An important set of results on human rhythms was obtained from subjects isolated in caves from 8 to 25 weeks The effect was that they developed sleep-wakefulness rhythms which were all longer than 24 hours, with the average being 24 hours and 42 minutes In another experiment by Aschoff, it was found that under isolation different human rhythms, such as body temperature sleep-wakefullness cycles, total urine volume, etc , were neither related to each other, nor do they have relation with solar day There also exists daily rhythms in the ability of the people to perform simple tasks For example, the ability to estimate an interval of 60 seconds varied with the time of the day Between 7 am and 1 pm there was a tendency to underestimate the interval, and whereas there was a tendency to overestimate it between 1 pm and 8 pm, these latter two times are the times when the estimates are most accurate A comparison between this and the body temperature shows that the two are related Blake made a comparison of the daily temperature variation of two groups of people one consisting of introverts and one of extroverts He found that body temperature of introverts rose earlier in morning, reached a maximum sooner, and fell earlier at night than that of the extroverts

It is to be noted that man, like all life on Earth, has evolved in an environment flooded with electromagnetic radiations of most wavelengths and varying degrees of coherence. The frequency spectrum, which living systems radiate and with which they are concerned probably extends from the ionizing ultraviolet radiation through non-ionizing, visible, microwave, radio and audio frequencies to sub-Hertz, perhaps even to the

frequency corresponding to reciprocal of the life-time of the organism itself, which clearly has a coherence in space and time throughout its existence However, the varying solar radiations at each sunspot maxima 11-year cycle coupled with galactic radiations at times, disturb the above coherence and give rise to many health effects, as mentioned in the preceding chapters To make use and curb any ill-bioeffects, Indian thinkers have propounded the *Kumbha* festival, where people overwrite their electromagnetic signatures through ritual baths and crop the benefit of naturally induced meditation physiology in *Yogik* meditation

Electromagnetic Field, Meditation and Initiation

As mentioned, each sunspot cycle enhances the electromagnetic field of the Earth and its environment, which, in turn, affects the biosystem variously Of the many bioeffects, the EM-field is reported to inhibit the regulatory systems, such as, nervous, endocrine, and circulatory, in mammals including man The in turn bioeffects of meditation resemble in many respects to EM-bioeffects The inhibitory effects of meditation on respiratory and circulatory system are manifested in marked decrease in rates of both oxygen consumption and carbondioxide elimination, and decline in concentration of blood lactate Meditation also leads to an increase in the intensity of "slow alpha' waves at 8 to 9 cycles/sec and in magnetic field of the brain, besides rapid rise in electrical resistance of the skin (140000 Ohms in 20 mts) (Wallace and Benson, 1972)

The EM-induced changes in nervous system are manifested in suppressed conditioned and unconditioned reflexes and altered encephalogram in favour of "slow" rhythms. The inhibitory effects of EM-fields on circulatory and respiratory system may also give rise to in turn effects of meditation Of the sections of the brain, the hypothalmus and cerebral cortex are highly magnetosensitive. The output by pituitary of certain hormones is altered It produces significant morpholo-

gical changes in gonads, adrenal and thyroid Changes in the circulatory system are manifested in vascular dialation

In view of these naturally induced meditation physiology, the need for spiritual meditation and new initiation into the fold of monkhood at *Kumbhas* has been much advocated in the ancient scriptures These spiritual affairs characterize the *Mela* and may be seen on the occasion in diverse forms

Bath Benefits

In view of the above spatio-temporally varying cosmobiological effects due to the electromagnetic fields ancient scriptures, particularly the *Puranas* prescribe, ritual bath thrice in a day in general and on new and full Moon days in particular in the *Ganga, Kaveri* and *Sipra* during the occasions of the *Kumbha* The traditions regard the waters of these rivers as virtuous in general and as nectar-like on the *Kumbha* occasions The *Puranic* concepts about the water qualities of these rivers find further support from a medical treatise of ancient India.

The *Carak Samhita* (Sutrasthama, 27, 209-212) classifies the rivers of India and hold that the rivers originating from Himalayas and constantly used by the sages having water obstructed, agitated and beaten are wholesome and virtuous The rivers originating from Malaya carrying stones and sand have clean water, which is like nectar The rivers flowing towards east are wholesome and while joining the western sea are mostly mild and heavy Waters of rivers originating from Pariyatra, Vindhya, and Sahya cause head diseases, heart diseases, leprosy and fileria. In this light, the rivers concerning the *Kumbha* are virtuous, and therefore, only the *Ganga, Sipra* and *Kaveri* were selected among others for the bathing festival. Since the water of these rivers are said to become like nectar especially on the *Kumbha,* it appears that ancients were aware of time dependent electromagnetic restructuring of water and its

bio-effects (Rai *et al.* 1992) The role of water quality and the electromagnetic fields for ritual bath has also been referred to in other religious texts

Biblical and Talmudic Writings on Water

Holy *Bible* (Genesis 1 1-20) assigns an important role for water and electromagnetic fields (light), in that order, thus, " the spirit of God was moving over the face of waters And God said let there be light" A similar importance is being given to water in the holy *Quran*, we made from water every living thing (Sura 21 30), It is he who has created man from water (Sura 25 54) There are biblical and talmudic prescription for ritual bathing (*Leviticus* 15·116–118) and descriptions of the contaminating effects of the carcasses of unclean creatures (*Leviticus* 11 24–40), which may, however, be cleansed by the prescribed washing of the person and clothing that has come into contact with them In the case of earthen vessels, ovens and stoves, these are to be broken into pieces to prevent further use

Nevertheless (*Leviticus* 11 36–38) a spring or cistern holding water shall be clean, but whatever touches their carcass shall be unclean And if any part of their carcass falls upon any seed for sowing that is to be sown, it is unclean, but if water is put on the seed and any part of their carcass falls upon it, it is unclean to you.

Preuss, (1978) writes For certain categorises of impurity, the *Bible* prescribes the requirement to bathe in "live (flowing) water", which tradition considers desirable for every ritual bath 'Live water, is that which flows from hills, but also the water of rivers (other than during the rainy season and during the time when the snows melt) and the seas A substitute for it is offered by the rainwater which gushes forth from the fountains of great deep (majenoth tehom rabba) (Genesis 7·11) in cases where it is collected in a reservoire, and if at least 40 Seahs (approx 800 litres) are present, that is as much as is required for a full grown

person to immerse himself in The column of water should be three cubic cubits, i e that covers a floor area of one square cubit and have a height of three cubits The basin (or reservoire) itself must naturally be large enough to hold not only the water but also the bather From the reservoires which are ordinarily found under the open sky, the rain water can be led through a pipe, *tzinor*, which may not be made of metal, however, into the true bathing basin the *mikveh*, drawn water in and of itself is absolutely unusable, however, one may add therefrom to well water or to the minimally prescribed quantity of rainwater It is similarly not permissible to bathe in a utensil such as a bathtub Scripture states (*Leviticus* 11 36–38) "only a well or a cistern, a gathering of water is clean, that is, it cleanses"

Preuss (1978) continues The ritual immersion bath was naturally required only in summer, but also in winter, and for that season the temperature of water was of utmost importance For High Priests, one warmed a bath on the day of Atonement, in case he was old or weakly, by adding hot water, or according to another interpretation, by placing pieces of iron, which were made red hot, into the water This was thus the opposite of the old Germanic stone baths, in which the hot water was poured on to glowing stones in order to produce steams

The biblical precept which applies only for pollution he shall wash his entire flesh in water (*Leviticus* 15 16–18), is extended to every ritual bath It is only valid when there is no separation between the body and the water Therefore, not only must all clothing and jewelry be removed, but the body must first be rid of all dirt (even under the nails) accidentally adherent blood, etc. From time immemorial, one, therefore, took a (warm) cleansing bath before entering the ritual immersion bath.

The regulation that every part of the body surface come in contact with the water has the result that one must also give consideration to the maintenance of

cleanliness of the water Otherwise, if any object, no matter how small, accidentally adheres to the skin, it serves as a separation between the body and the water and thus renders the immersion invalid The very basis for the above ritual baths seems to be related to the properties of E M induced restructured water from various sources

Structure of Water and Its Electromagnetic Properties

To understand the structure of water, the arrangement of oxygen and hydrogen atoms in ice crystals have been determined by X-rays and other means The two hydrogens are bonded to the oxygen at an angle of 105 degrees The exact arrangement of molecules in the ice crystal is not known with certainly, we know that they form a hexagonal structure Each molecule is surrounded by four nearest neighbours, so that the group has one molecule at the centre and the other four at the corners of a tetrahedron The molecules and groups of molecules are joined together by hydrogen bonds

The forces of attraction between the molecules in ice or water produce a strong inward pressure, which accounts for water's peculiar properties According to X-ray determinations, the average distance between the centre of one oxygen atom and the centre of the next in the ice crystal is 2.72 Angstrom units (1 Angstrom = one hundred-millionth of a centimetre). When ice melts to liquid water, the hydrogen bonds are stretched and the molecules move farther apart· the distance between oxygen is increased to about 2 9 Angstroms on the average This stretching would open the structure further and make water less dense Each molecule is now surrounded by five or more neighbours instead of only four

The chaotic disorder in which water molecules exist in the liquid state is difficult to picture Their arrangements shift continually. The angle between the two hydrogen atoms in water molecule no longer remains fixed near a right angle but becomes variable, so that

the molecule is flexible Each oxygen atom now attracts by electrical forces not only two extra hydrogen atoms as in ice, but three or more Thus we may find an oxygen atom surrounded by five or six hydrogens and a hydrogen atom surrounded by as many as three oxygens In the closely knit, flexible structure the hydrogens constantly shift their positions and displace one another Each such displacement is propagated in a chain or zipper fashion throughout the liquid This has consequences which affect the viscosity, dielectric constant and electrical conductivity of water

The motion of water molecules in liquid state is rolling rather than sliding Since the molecules are connected by hydrogen bonds, at least one bond must be broken before any flow can occur From the fact that the molecules are bonded together, it might be expected theoretically that the viscosity of water should be comparatively high However, each hydrogen bond in water is shared on the average between two other molecules, and one of these weakened bond is easily broken The greater viscosity of ice is due to the fact that each hydrogen is bonded to only a single oxygen atom from another molecule, and this firmer bond must be broken before any movement can occur

The dielectric constant of a liquid is a measure of its capacity to neutralize the attraction between electrical charges The water has a high dielectric constant It reduces the force of attraction between the oppositely charged ions in solution to not more than 1 percent of the original value The reason for water's strong neutralizing action lies in the arrangement of its molecule In an aggregation of water molecules a hydrogen atom does not share its electron equally with the oxygen atom to which it is attached . the electron is closer to the oxygen atom than to the hydrogen As a result the hydrogen atoms are positively charged and the oxygen atom negatively charged In presence of ions, the oxygen atoms are attracted to positive and the hydrogens to the negative ones Consequently, water molecules

surrounding a positive ion are oriented with their oxygens next to the ion, and molecules around a negative ion turn their hydrogen toward the ion Thus the water molecules act as cages which separate and neutralizes the ion

The electrical conductivity of water is due to impurities dissolved in it and otherwise from the jumping of hydrogen ions

The strong bonding of water molecules accounts for the fact that water has unusually high melting and boiling points because of high energy of hydrogen bonds Calculations indicate that the total energy of the hydrogen bonds in one mole of water (18 gms) is equivalent to 6000 calories There are accumulating evidence showing that the above properties of water undergo changes in electromagnetic fields These changes depend on the field characteristics

In our recent experiment, we noted the magnetic effects on water as pole, field-strength and length of exposure dependent The first effect noted was adiabatic thermal changes up to four hours and then constant The increase in temperature could be attributed to the energy evolved from the breakage of hydrogen bonds (6000 calories/18 gms H_2O). The X-ray observation shows that magnetic fields exert stress that initially leads to stretching in hydrogen bonds, which on increasing length of exposure provides ordering to water molecules The spectral data suggest that EM-field causes time-dependent water structuring varying from monomers through cloth rate-hydrate frameworks to liquid crystal, each remembering the field signatures for extended period of time

Synthesis from the latest work enables one to begin to appreciate how water can remember frequencies and chemical structures to which it has been exposed

Del Giudice *et al.* (1988) propose that coherent interactions between water electric dipoles and the radiation can generate ordered structure in macroscopic

domains of the order of a 100 microns in size Such domains could be the basis for the memory properties of water Del Guidice and Preparata consider the consequences of a laser mechanism acting in liquid water which is predicted to behave as a physical system far from equilibrium A consequence of highly coherent structuring is that within the structured region, as in electron beam laser, the relation-frequency times wavelength equals the constant velocity of propagation of the electromagnetic wave, does not apply Rather, the wavelength is constant and there are many velocities and proportional frequencies The constancy of wavelength within a highly coherent region makes, the frequency proportional to the velocity, this, in turn, will be proportional to the charge hopping rate, where the maximum rate is 10^{11} hops/sec

The only symmetry suitable for structuring water by a magnetic field is a helical or toroidal symmetry The bond angles of water molecule lead naturally to a basic pentagonal structure for their simplest planner arrangement These should form naturally into a docecahedron (a 12-sided,near spherical cavity) at the interface of collapsing bubbles formed by succession of a homoeopathic potency The combination of this criteria leads to a pearl-chain of docecahedron cavities around the surface of which electrical currents arising from coherent jumping of the hydrogen bonds would circulate in solenoid path A pearl-chain of docecahedron would also provide a helical structure and this would make the fundamental "bit" for information storage

It was found that water exposed to magnetic field of a patient's neutralizing frequency has a clinical effect as if it were a homoeopathically potentised remedy of the patients neutralizing dilution of allergen. There is evidence that information can be electromagnetically written into environmental water and the effects corresponding to the frequencies of the electromagnetic fields can be precisely retained by water for extended periods and a reacting allergic subject should be able to 'read

out' this information at a later time by electromagnetically 'zapping' the environment (Smith and Best, 1989)

As mentioned, the cosmobiological effects at *Kumbhas* are caused by the increased electromagnetic radiations and charged particles from the Sun and the Moon, the flux of which also varies in accordance with the positions of the Sun and the phases of the Moon and also by the plus or minus signs of the sunspots Thus varying electromagnetic radiations causing differing bioeffects gets imprinted and stored into the memory "bits" of the river waters for the extended period of about 2 to 3 months (Smith and Best, 1989) Such waters can conversely overwrite the electromagnetic signatures manifest as health-effects in the living systems, similar to homoeopathic medicine Thus resulting properties of the water has been referred to as *Amrit* in the *Puranas*, especially on the eve of the *Kumbhas* In view of these, the *Puranas* have prescribed bathing rites thrice daily and especially on the full and new Moon days so that people may 'readout' their electromagnetic signatures and restore their health.

The apparent ability of water to 'remember' frequencies also enhances the straight forward electromagnetic effects of the environmental sources of highly coherent frequencies Hence the siting of the *Mela* on the banks of the rivers was planned to restore the electromagnetic coherence in the people

The *Kumbha Mela*, on the whole, thus reveals the scientific wisdom of the ancient Indian thinkers and represents the scientific religions of India where people get the physical and spiritual benefits. Because of the naturally induced meditation physiology, this *Mela* is generally connected with spirituality.

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